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THE COMMERCIAL OTTER TRAWL SHRIMP FISHERY OF COOK INLET

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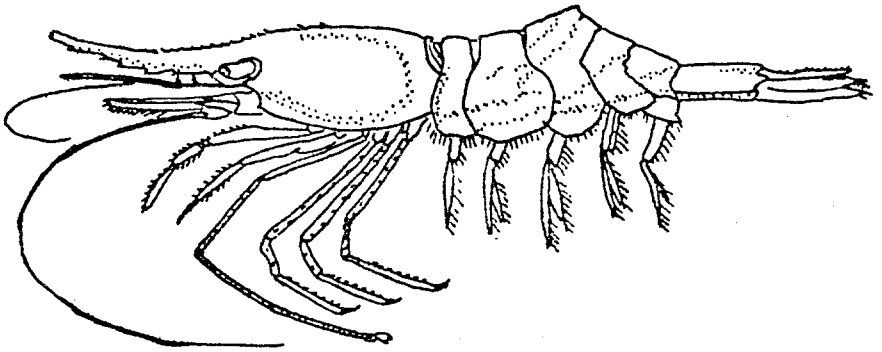

Humpy Shrimp
Pandalus goniurus

By

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ABSTRACT

The Lower Cook Inlet trawl shrimp fishery has harvested about 5 million lbs of shrimp annually since 1970. The major pandalid shrimp species captured by the fishery include: pink *(Pandalus borealis)*, humpy *(P. goniurus)*, coonstripe *(P. hypsinotus)*, and sidestripe *(Pandalopsis dispar)*. Pink shrimp have comprised 52.7% of the 12-year harvest. Fishing effort has varied between 4 and 22 vessels annually. The catch per unit effort suggests that crew and vessels have become more efficient in recent years partially as a result of shorter fishing periods and more competition. Population trends based on trawl index surveys suggest that fluctuations have occurred, especially in the humpy shrimp stock. Pink shrimp appear to be less variable in their stock size. Growth and age information for the commercial pandalid shrimp species are presented, as well as length-weight relationships.

I. Commercial Trawl Shrimp Fishery II. Davis, Allen S., Author
III. Cook Inlet Commercial Fishery IV. Pandalid Shrimp

THE COMMERCIAL OTTER TRAWL SHRIMP FISHERY OF COOK INLET

INTRODUCTION

Landings of pandalid shrimp, primarily pink shrimp *Pandalus borealis* from the otter trawl fisheries in Alaska on a statewide basis have declined dramatically since the record high catch of 129 million lb (58.6 million kg) in 1976. The 1981 harvest totaled 28.1 million lb (12.8 million kg) (Figure 1) and reflects the continued depression of most stocks in the Kodiak, Chignik, Alaska Peninsula, and Aleutian shrimp districts (Figure 2).

Otter trawl catches in the Cook Inlet area during this same time period have remained relatively constant due in part to the following reasons:

(1) Cannery imposed daily catch limits,

(2) exclusive registration area,

(3) limited processing facilities,

(4) conservative guideline harvest levels, and

(5) management policies utilizing fishing periods and closed areas.

Based on Alaska Department of Fish and Game (ADF&G) trawl index surveys and catch per unit effort (CPUE) data from the commercial fishery, the population abundance of pandalid shrimp in Cook Inlet has fluctuated during this same time period. The total annual harvest is not necessarily indicative of stock size.

It appears from these data that the Cook Inlet area will sustain a minimum annual fishing mortality equal to historic levels provided the abundance index remains as high as the values previously measured and the rate of harvest over a given time period is maintained.

This paper discusses characteristics of the commercial trawl shrimp fishery in Lower Cook Inlet and associated research conducted on the resource. Reasons for historic harvest consistency are suggested as well as future management considerations.

CHARACTERISTICS OF THE FISHERY

Description of Area

For purposes of shrimp management, Cook Inlet is separated into two areas as shown on Figure 3. (Cook Inlet "H" and Outer Cook Inlet "G").

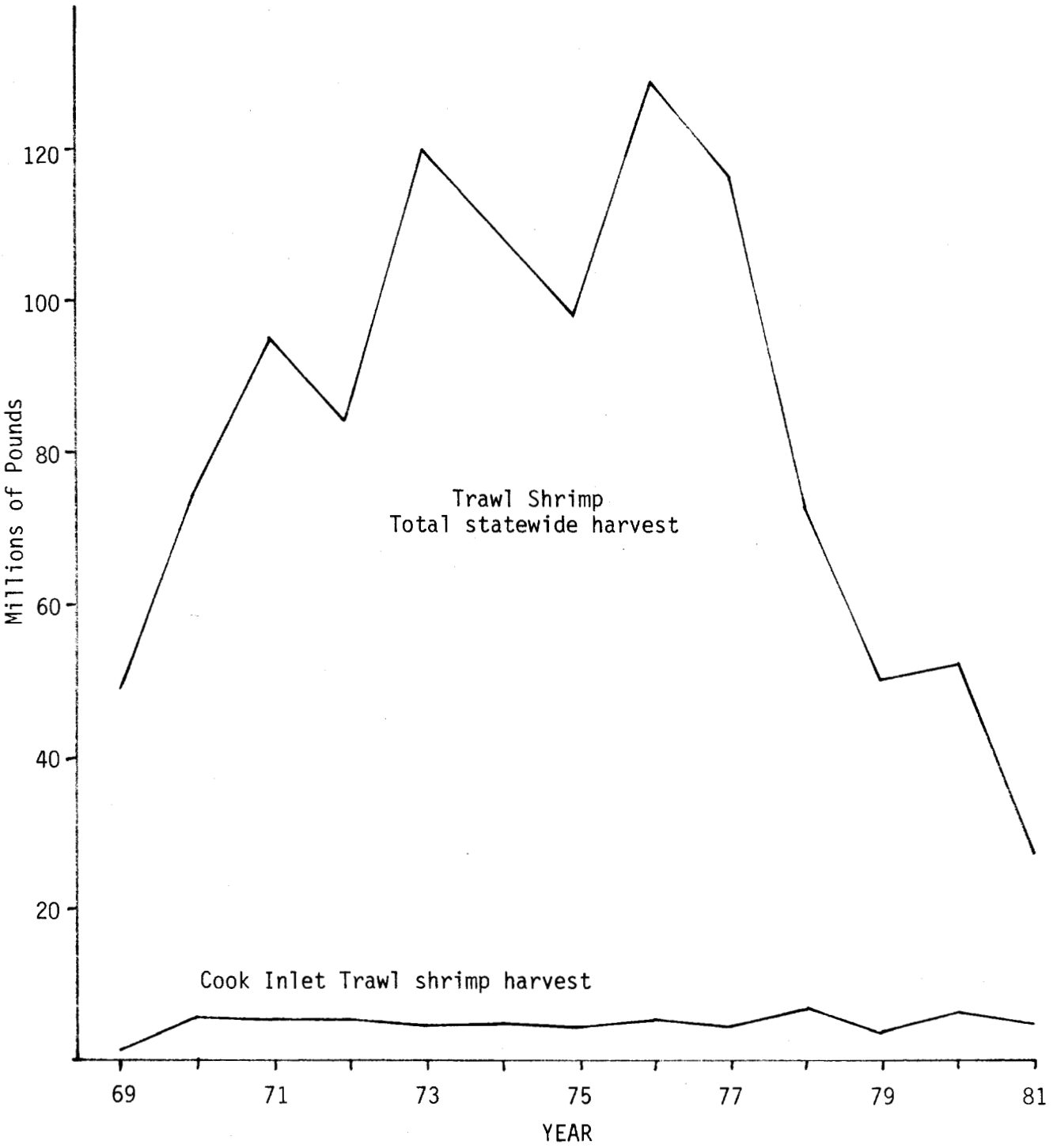


Figure 1. Annual harvests of trawl shrimp from all areas in Alaska combined and from Cook Inlet area only, 1969 - 1981. (Source: 32nd annual report - PMFC, 1980).

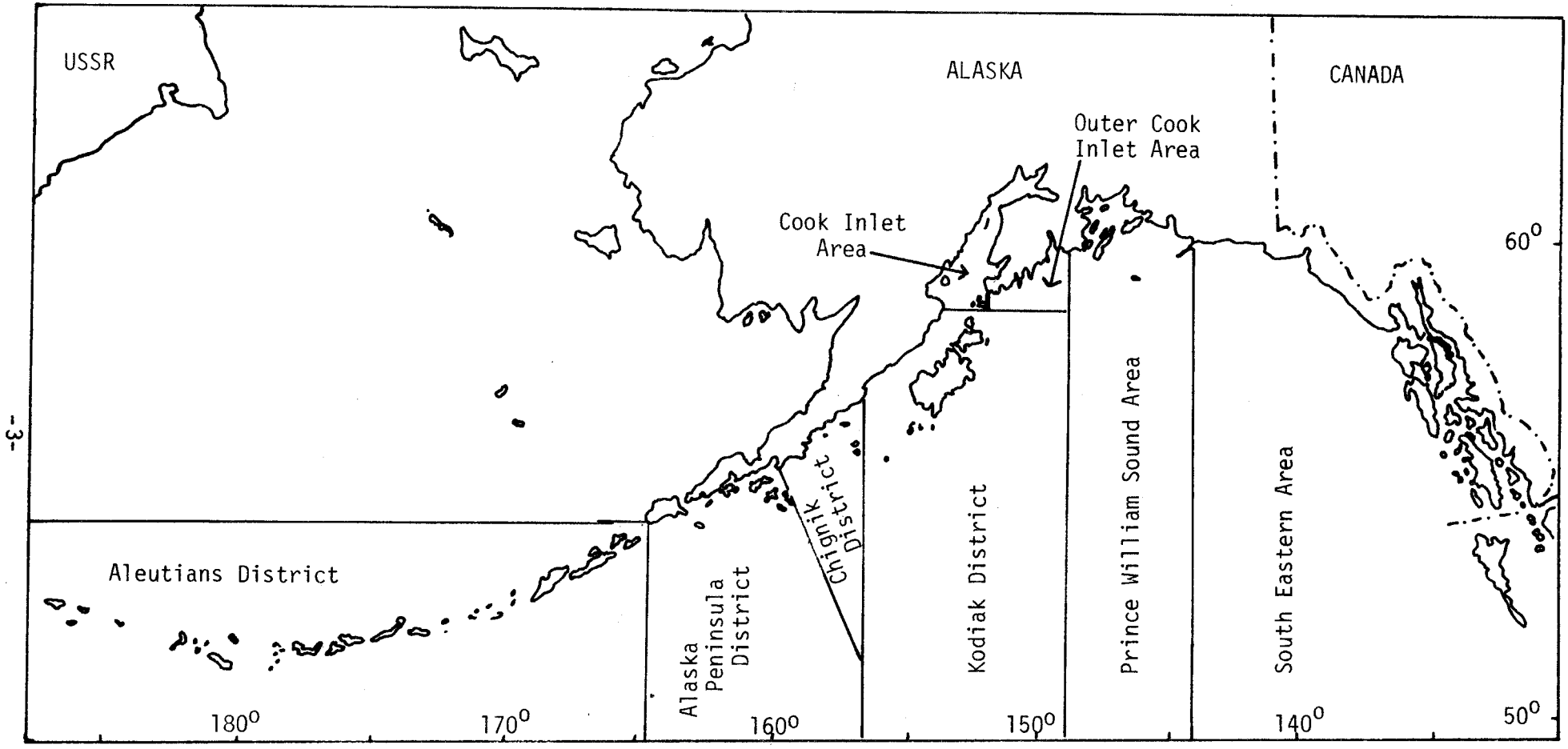


Figure 2 . Shrimp fishing areas and districts within Alaska.

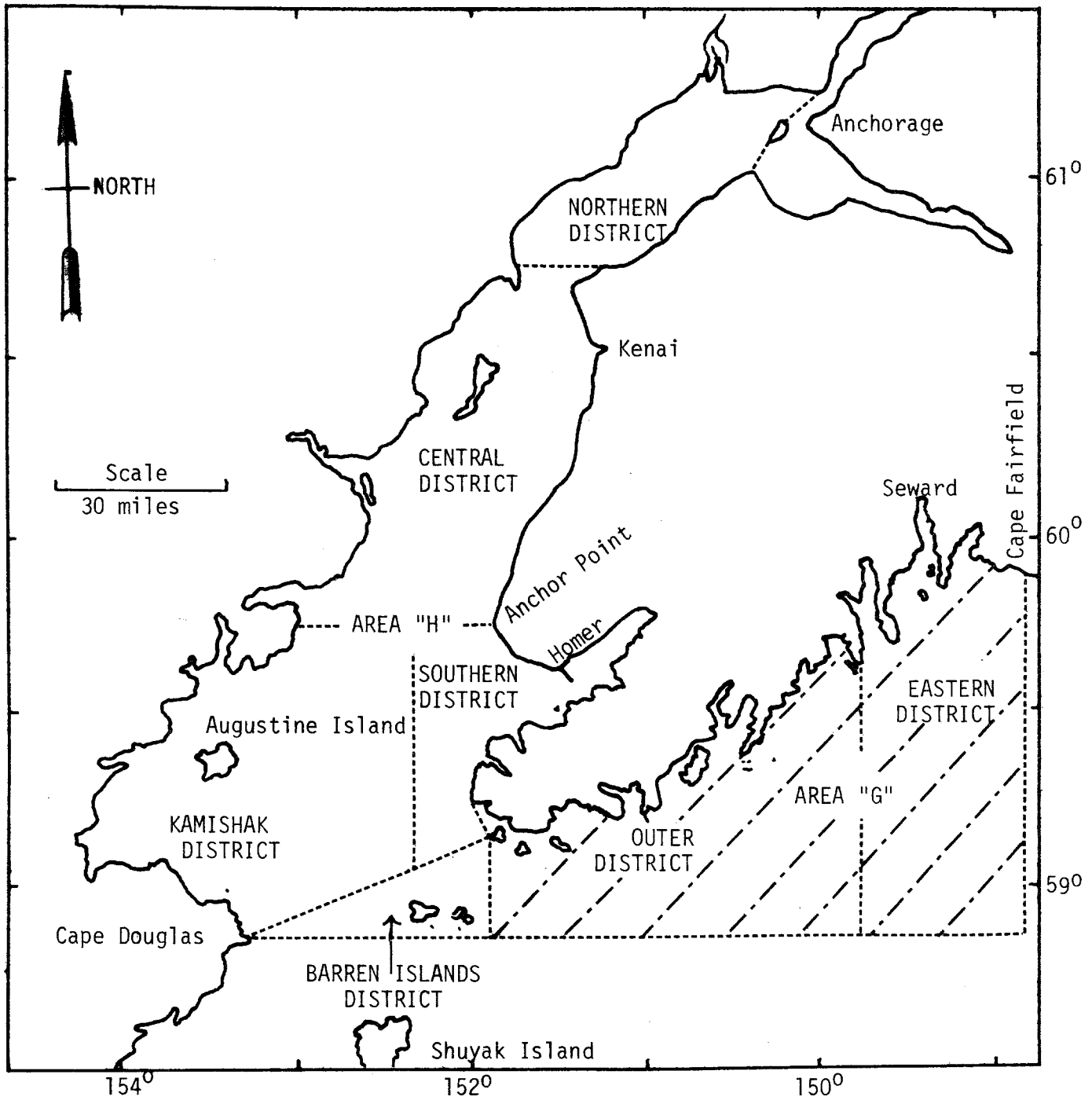


Figure 3 . Cook Inlet area ("H") and Outer Cook Inlet area ("G") district location chart.

The major trawl shrimp fishery in Lower Cook Inlet occurs in the Southern District primarily within the Kachemak Bay area. Area G, which includes the Outer and Eastern Districts on the southern side of the Kenai Peninsula, was established by the Board of Fisheries in the spring of 1977. Area G is a so-called nonexclusive fishing area and is designed to attract fishermen into the unexploited shrimp stocks of the area. Exploratory cruises have indicated that some limited stocks of pandalid shrimp species are available.

Figure 4 shows the Kachemak Bay area of Lower Cook Inlet. The cross hatch areas indicate regions of known commercial trawl shrimp fishing activity. The area east of a line from Anchor Point to Point Pogibshi is regulated by guideline harvest levels.

Stocks of pandalid shrimp within Kachemak Bay inhabit areas from Point Pogibshi to Bear Cove generally in waters deeper than 10 fm with major areas of abundance in waters deeper than 30 fm. Figure 5 shows approximate depth contours of 30, 50, and 90 fm (55, 91, and 165 m) for Kachemak Bay. For purposes of stock abundance surveys and population estimates, shrimp inhabit about 75 mi^2 (194.2 km^2) of bottom area within Kachemak Bay.

Species of Shrimp Commercially Exploited

The major species of pandalid shrimp exploited in the trawl shrimp fishery are pink shrimp, humpy shrimp, *P. goniurus*; coonstripe shrimp, *P. hypsinotus*; sidestripe shrimp, *Pandalopsis dispar;* and occasionally spot shrimp, *Pandalus platyceros*. The so-called "coonstripe shrimp" of Puget Sound *Pandalus danae* is occasionally captured. Other species of shrimp are commonly taken in the trawl shrimp fishery in the families Crangonidae and Hippolytidae, however, the catches are not in commercial quantities.

There is also a pot shrimp fishery which exploits the coonstripe and pot shrimp populations in the Southern District. Data and results of sampling from this fishery are reported by Davis (1980).

History of Exploitation

Relatively small landings of shrimp (4-5,000 lb annually) were recorded as harvested in the Kachemak Bay area in 1952 and 1953. Commercial harvesting of shrimp in the 1950's and early 1960's was somewhat intermittent and catches do not reflect the size of the stock in the area. Table 1 lists the number of boats, deliveries, and catches for the years 1962 through 1981 on an annual basis for the Cook Inlet area. The number of vessels has varied from a low of one during 1968 to a high of 22 in 1981. The number of deliveries was affected by the daily cannery-imposed quota and the cannery policy of delivering shrimp the same day as captured. In more recent years, ice has been used so the shrimp are held on board for a longer time period, therefore, larger loads have been delivered.

Seasonal catches of both trawl and pot shrimp are located in Table 2. In the late 1950's and early 1960's shrimp peelers were operated in Seldovia (Figure 4) until the Good Friday earthquake in 1964 which flooded out the processing facility. During that time period there were also attempts at

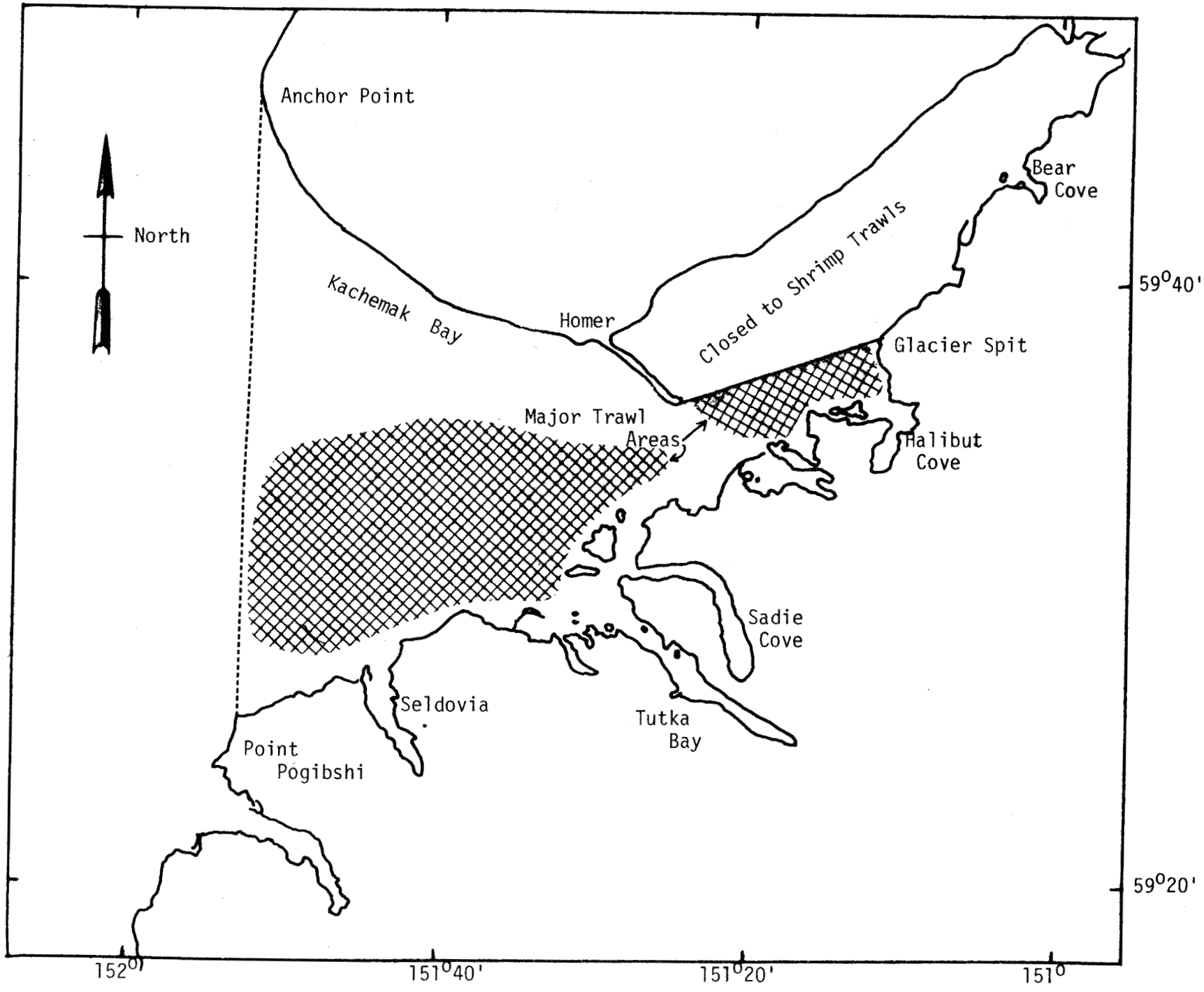


Figure 4. Location of commercial shrimp trawling in Kachemak Bay.

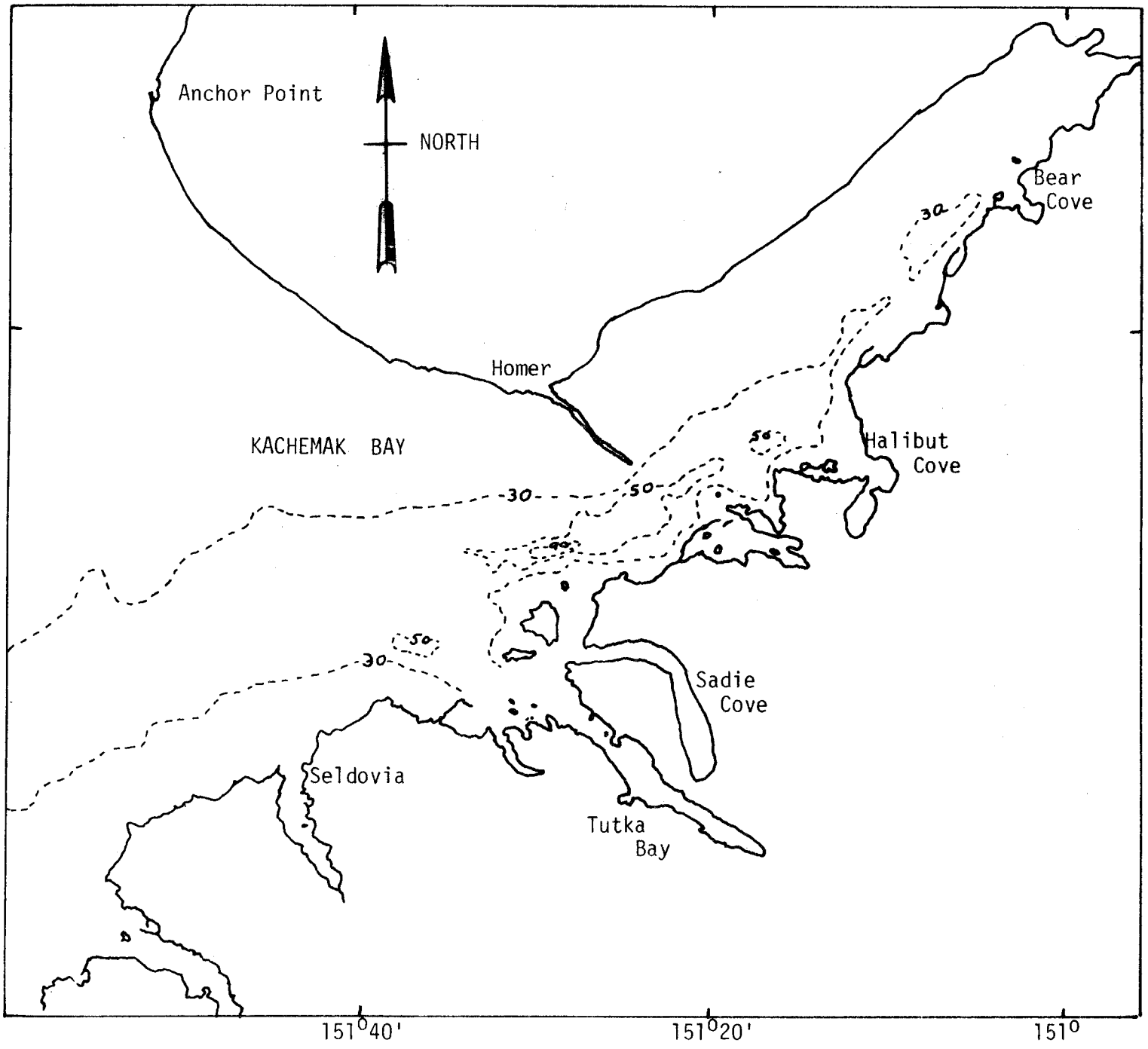


Figure 5. Depth contours (30, 50, 90 Fathoms) of Kachemak Bay.

Table 1. Number of deliveries and catch per delivery for the otter trawl fishery in Cook Inlet 1962 - 1981 on an annual basis.

Year	Boats	Deliveries	Thou. lb Catch	Thou. lb Catch/Delivery
1962	2	39	403	10.3
1963	7	169	1,898	11.2
1964	5	48	600	12.5
1965	2	38	61	1.6
1966	2	54	286	5.3
1967	3	70	733	10.5
1968	1	20	25	1.2
1969	5	252	1,850	7.3
1970	3	537	5,808	10.8
1971	7	559	5,395	9.7
1972	7	428	5,377	12.6
1973	13	324	4,550	14.0
1974	9	354	5,064	14.3
1975	4	421	4,526	8.7
1976	4	473	5,769	12.2
1977	5	367	4,642[1]	12.7
1978	6	357	7,186[1]	20.1
1979	7	161	4,070[1]	25.3
1980	19	261	6,144[1]	23.5
1981	22	276	5,031[1]	18.2

[1] Preliminary information

Data Source: ADF&G Statistical Report.

Table 2. Final shrimp catches by guideline harvest level period for Southern District, Cook Inlet.

Year	Trawl Shrimp Catches				Pot Shrimp Catches			
	Jun 1-Oct 31	Nov 1-Mar 31		Total	Jun 1-Sep 30 (100,000 lb.)	Oct 1-May 31 (500,000 lb.)		Total
1969-70[1]	1,292,651	1,692,854		2,985,505				
1970-71[1]	3,211,924	2,076,228		5,288,152	3,606	7,602		11,208
1971-72[1]	2,618,630	1,761,569		4,380,199	8,836	70,601		79,437
1972-73[1]	2,722,422	2,109,660		4,832,082	75,247	184,230		259,477
1973-74	2,502,154	2,323,780		4,825,934	63,181	738,165		801,346
1974-75	2,512,764	2,519,148		5,031,912	43,650	126,472		170,122
1975-76	1,997,563	2,421,456		4,491,019	100,765	273,758		374,523
1976-77	2,545,885	2,453,101		4,998,986	52,115	199,559		251,674
1977-78	2,490,969	2,546,977		5,037,946	85,511	511,938		597,449
1978-79[2]	2,952,733	3,060,066		6,012,799	49,080	121,234		170,314
	Jul 1-Sep 30	Oct 1-Dec 31	Jan 1-Mar 31					
1979-80[2]	2,013,298	2,052,646	1,731,483	5,797,427	59,963	177,927		237,890
1980-81[2]	1,780,677	2,691,746	1,704,706	6,177,129	74,368	134,275[3]	104,716[4]	317,034
1981-82[2]	1,614,073	1,695,332			56,092	47,859[3]	40,000[4]	143,951

Data Source: Final Computer Run
[1] Catches do not include April and May landings.
[2] Preliminary data
[3] November 1 - December 31 season.
[4] February 1 - March 31 season.

processing shrimp in the Seward area. Some loads of shrimp were captured in the Kachemak Bay area and hauled to Seward, however, the majority of the product landed in Seward came from the Kodiak area. In the late 1960's shrimp peelers were installed in Homer and shrimp catches reached the 5 million lb (2.3 million kg) level seasonally and have remained near that level to the present time period.

The catches by month by year for the Cook Inlet otter trawl fishery are graphed on Figure 6 for 1967 to time of this report preparation in 1982. These graphs show that the monthly catch remained below 1 million lb (454 thousand kg), until 1978 when additional fishing effort increased the monthly harvest above the 1 million lb level [2.3 million lb (1 million kg) in November] during 3 months. Regulations were enacted during 1979 to spread catches out over time periods similar to historic catch rates and prevent "pulse" fishing common in other otter trawl fisheries of the Gulf of Alaska. These unique Cook Inlet regulations are discussed further in the "history of management" section below.

The commercial trawl fishery for shrimp occurs both west and east of the Homer Spit (Figure 4). The major area of harvest has been west of the spit with some exceptions. Table 3 lists the percentage of the yearly harvest landed from each of the areas by monthly periods. During the 1969-1971 period relatively high percentages of shrimp were captured east of the spit primarily in the winter months. Virtually all of trawl landings from 1972-1974 were captured west of the spit. In recent years, fishing east of the spit occurred during inclement weather days. Also a high incidence of fish in the shrimp catch caused the fleet to shift effort east of the spit during the winters of 1977, 1978, 1981, and 1982.

History of Management Regulations

Prior to 1971 there were no closed seasons or guideline harvest levels for the trawl shrimp fishery of Cook Inlet. Table 4 lists regulations pertaining to seasons and guideline harvest levels for the Cook Inlet area. Southern District guideline harvest levels were first established during the 1971-72 fishing season as two separate amounts, 3 million lb (1.3 million kg) from 16 April to 14 October 1971 and 2 million lb (908 thousand kg) from 15 October to 15 April 1972. Vessels landing shrimp at the Homer processing facility were restricted to a daily catch limit by the cannery. The limit was set at the processing capability of the facility.

During the 1970's fishing seasons were curtailed during the spring egg hatch period to protect congregating egg-bearing females. From the 1973-74 season to the 1978-79 season, opening dates were 1 June and 1 November, while closing dates depended on catch and effort. In the fall of 1979 trawl vessel effort increased and the second season amounted to only 5 weeks total for the 3.0 million lb harvest. Starting with the 1979-80 season a "Kachemak Bay trawl shrimp management plan" was enacted by the Board of Fisheries. A copy of this plan is shown in Appendix A.

In summary, the plan maintains the present harvest characteristics similar to historic fishing. The harvest is spread out into three guideline harvest level periods with a minimum of 9 weeks fished in each period. The three

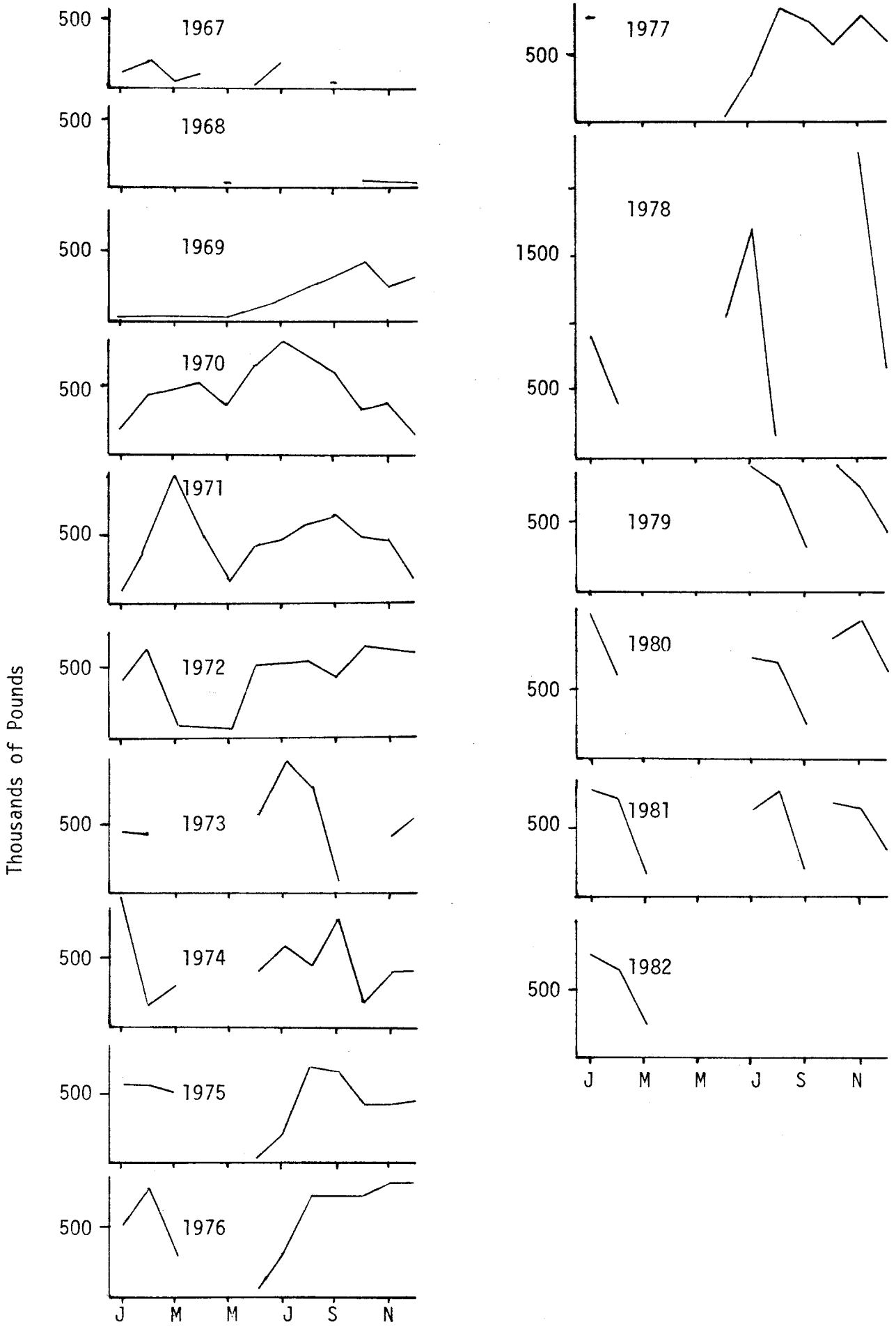


Figure 6 . Harvest of trawl shrimp by month in Southern District.

Table 3. Percent of annual shrimp landings captured west and east of the Homer Spit by monthly period and year.

	WEST OF SPIT				EAST OF SPIT			
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
1969		21.2	29.6	6.4			1.7	41.1
1970		25.5	31.5	7.8	26.0	5.1		6.2
1971	20.2	16.4	27.3	20.7	15.0		0.5	
1972	15.5	12.8	40.6	31.2				
1973	12.4	9.4	33.0	45.2				
1974	21.4	12.0	44.7	21.6				0.2
1975	31.3	0.1	39.6	11.2				17.8
1976	21.8	.8	37.6	23.6	1.6		0.6	14.0
1977	9.8	closed	36.8	32.6	4.6	closed	5.9	10.4
1978	1.3	17.7	18.4	32.6	20.6	3.6	0.3	5.5
1979	closed	closed	54.6	41.0	closed	closed		4.4
1980	22.1	closed	26.7	28.7	15.9	closed	0.1	6.5
1981	26.6	closed	31.3	20.9	10.0	closed	0	11.2
1982								

Data Source: Commercial Trawl Logbooks.

Table 4. Summary of regulations for the trawl shrimp fisheries of Cook Inlet

Year	District	Actual Season From	To	Guideline Harvest Level	Registration
1968	All	No Closed Season			
1969	"	"	"		
1970	"	"	"		
1971-72	Southern	04/16/71	10/14/71	3.0 m lbs.	
		10/15/71	04/15/72	2.0 m lbs.	
1972-73	Southern	04/16/72	10/14/72	3.0 m lbs.	
		10/15/72	02/11/73	2.5 m lbs.	
1973-74	Southern	06/01/73	09/05/73	2.5 m lbs.	Non Exclusive
		11/01/73	01/14/74	2.5 m lbs.	
	Other	06/01/73	03/31/74		
1974-75	Southern	06/01/74	10/01/74	2.5 m lbs.	Exclusive
		11/01/74	03/13/75	2.5 m lbs.	"
	Other	06/01/74	03/31/75		"
1975-76	Southern	06/01/75	10/31/75	2.5 m lbs.	"
		11/01/75	03/04/76	2.5 m lbs.	"
	Other	06/01/75	03/31/76		"
1976-77	Southern	06/01/76	10/22/76	2.5 m lbs.	"
		11/01/76	01/30/77	2.5 m lbs.	"
	Other	06/01/76	03/31/77		"
1977-78	(H) Southern	06/01/77	10/11/77	2.5 m lbs.	"
		11/01/77	02/28/78	2.5 m lbs.	"
	(G) Outer-Eastern	06/01/77	02/28/78		Non Exclusive
1978-79	Southern	06/01/78	08/03/78	3.0 m lbs.[1]	Exclusive
		11/01/78	12/08/78	3.0 m lbs.[1]	"
	Outer-Eastern	04/10/78	05/31/78		Non Exclusive
		06/01/78	02/28/78		
1979-80	Southern	07/02/79	09/11/79[1]	2.0 m lbs.	Exclusive
		10/01/79	12/19/79[1]	2.0 m lbs.	"
		01/03/80	02/25/80[1]	1.7 m lbs.	"
	Outer-Eastern	No Closed Season			Non Exclusive
1980-81	Southern	07/01/80	09/02/80	1.8 m lbs.	Exclusive
		10/01/80	12/16/80	2.7 m lbs.	
		01/05/81	03/02/81	1.7 m lbs.	
	Outer-Eastern	No Closed Season			Non Exclusive
1981-82	Southern	07/06/81	09/08/81	1.7 m lbs.	Exclusive
		10/05/81	12/14/81	1.7 m lbs.	
		01/04/82	03/01/82	1.7 m lbs.	
	Outer-Eastern	No Closed Season			Non Exclusive

[1] Weekly fishing periods

seasons are set to insure that all species and all segments of the stocks are harvested.

In order to maintain the harvest rate at the prescribed schedule, weekly fishing periods have been used since the 1979-80 season. Appendix Table 1 summarizes the fishing periods for the three fishing seasons from 1979-80 through 1981-82. Fishing periods have varied in length depending on effort, catch rates, weather, and weekly catch quotas. These data are further discussed in the section below concerning "current management methods".

The Cook Inlet area has been an exclusive registration area starting with the spring of 1974 (Table 4), and remains the only exclusive trawl shrimp registration area in the state to the date of this report. Starting with the 1977-78 season the Cook Inlet area was divided into two registration areas for shrimp management; Cook Inlet area "H" and Outer Cook Inlet area "G" (Figure 3). Area "H" remained an exclusive registration area and Area "G" was made a nonexclusive area with the added provision that vessels registered to fish in Area "H" may also register to fish in Area "G".

The upper portion of Kachemak Bay northeast of a line from the end of Homer Spit to Glacier Spit (Figure 4) has been closed to shrimp trawling since the start of the fishery. This closure was enacted to protect small shrimp that are abundant in the area.

During the 1980-81 season a portion of the fishing fleet began shrimp trawling in Sadie Cove-Tutka Bay area. By the end of the season the entire fleet was dragging in Sadie Cove. The bottom area suitable for dragging amounted to about 2 mi^2 (3 km^2). Humpy shrimp (egg-bearing females) were concentrated in the bay along with relatively small-sized pink shrimp. Due to the small area available for fishing, the possibility that overharvesting could occur, and the fishing area was inconsistent with historic fishing grounds, the Tutka Bay and Sadie Cove areas were closed to trawling starting with the 1981-82 season.

During the 1981-82 fishery vessel effort and catch rates reached a point where each week's allowable harvest was attained in a matter of hours. The short periods forced each vessel's crew to maximize their respective fishing operations. A portion of the trawl fleet fished on the day preceding the commercial season under the guise of subsistence fishing. This exploratory or so-called "subsistence" fishing resulted in substantial deadloss that was unreported and was in addition to the allowable harvest. Since there was no valid declaration of subsistence fishing with trawls in the area, subsistence fishing with trawls was closed effective from 14 November 1981 to 15 March 1982.

Present Management Methods

The trawl shrimp fishery is managed along the guidelines set forth in the "Kachemak Bay Trawl Shrimp Management Plan" (Appendix A). Abundance index estimates (discussed in detail in the "Biological and Environmental Descriptors" section below) provide two annual measurements of shrimp biomass in May and October. These indexes are considered non-linear estimates. For example; if succeeding May values double in number, it does not mean the shrimp population has doubled. With the historic data base available it has been considered

that the shrimp stock can sustain a minimum 5.0 million lb annual harvest provided abundance index values remain equal or above historic levels.

The annual harvest is divided into three season amounts; each of the three seasons is further divided into at least 9 weekly periods. During the day to day management, vessels engaged in the fishery contact the Homer office of ADF&G by VHF radio and provide catch estimates. These estimates are generally transmitted in code form. The number of checks depends on fleet catch rates but generally vessels are contacted at 2 to 4 hour intervals. When the fleet catch rate is established, the number of hours of fishing time allowed is calculated as shown on Figure 7, which plots hourly catch rates versus the weekly catch total. These catch rates have to be adjusted for the percentage of fish captured incidental to the shrimp harvest. Consideration is also given to the shrimp species composition of the commercial harvest. Based on commercial catch sampling, the catch by species is maintained consistent with stock abundance estimates when possible.

During the 1981-82 season, fishing periods ranged in length from 3.5 to 114 hours. The longest period was the result of extreme cold weather conditions and minimal fishing effort.

Catch per unit effort of the commercial fleet is also considered during the season. These data are used as additional in-season information to determine stock status and exploitation rates. The CPUE data is viewed conservatively because of the changing nature of the trawl fishery. Increased competition in recent years has forced trawl vessels to become more efficient, thereby negating relationships between historic and present day CPUE data.

Catch Per Unit of Effort

Logbooks are filled out by most of the trawl shrimp fishermen in the Southern District fishery and copies of these data are made available to the ADF&G for analysis. These logbooks list area fished, actual time net was on the bottom, estimated catch, and other information. Logbook information concerning time and area fished is compared to the actual fish ticket information from the canneries to determine the CPUE. The fish ticket information from the canneries lists only pounds of shrimp landed with the fish poundage removed from the total.

The monthly combined CPUE information for the three boat skippers that have engaged in the fishery for the longest time is listed in Appendix Table 2 through 4. These data are weighted by catch information; no other standardization factors are involved in comparing the three vessels. A summary of the CPUE information is graphed on Figure 8 showing the average CPUE by fishing year. The number of years and the average CPUE for each fishing year starting with the 1969-70 season is listed in the bottom graph. The average CPUE is shown by the dot and the range is shown by the vertical line on each side of the dot. The last 3 years CPUE have been very similar in magnitude. The highest values occurred during the 1973-74 fishing season when humpy shrimp were abundant and available to the fishery.

The upper graph of Figure 8 shows CPUE by month. These data are again weighted by catch to derive the weighted average and the range is again shown by the

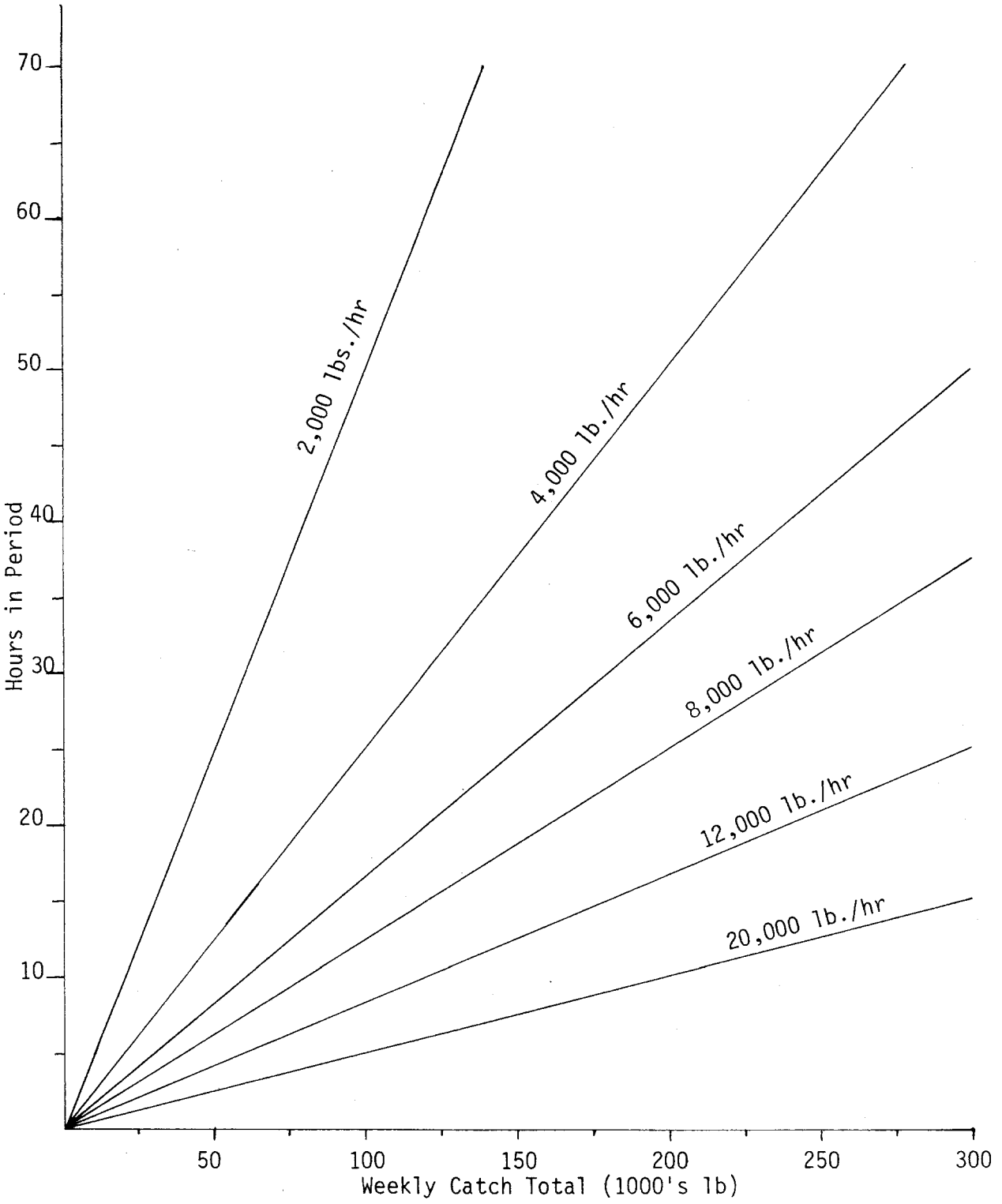


Figure 7 . Total hours per period at selected catch rates for trawl shrimp fishery of the Southern District.

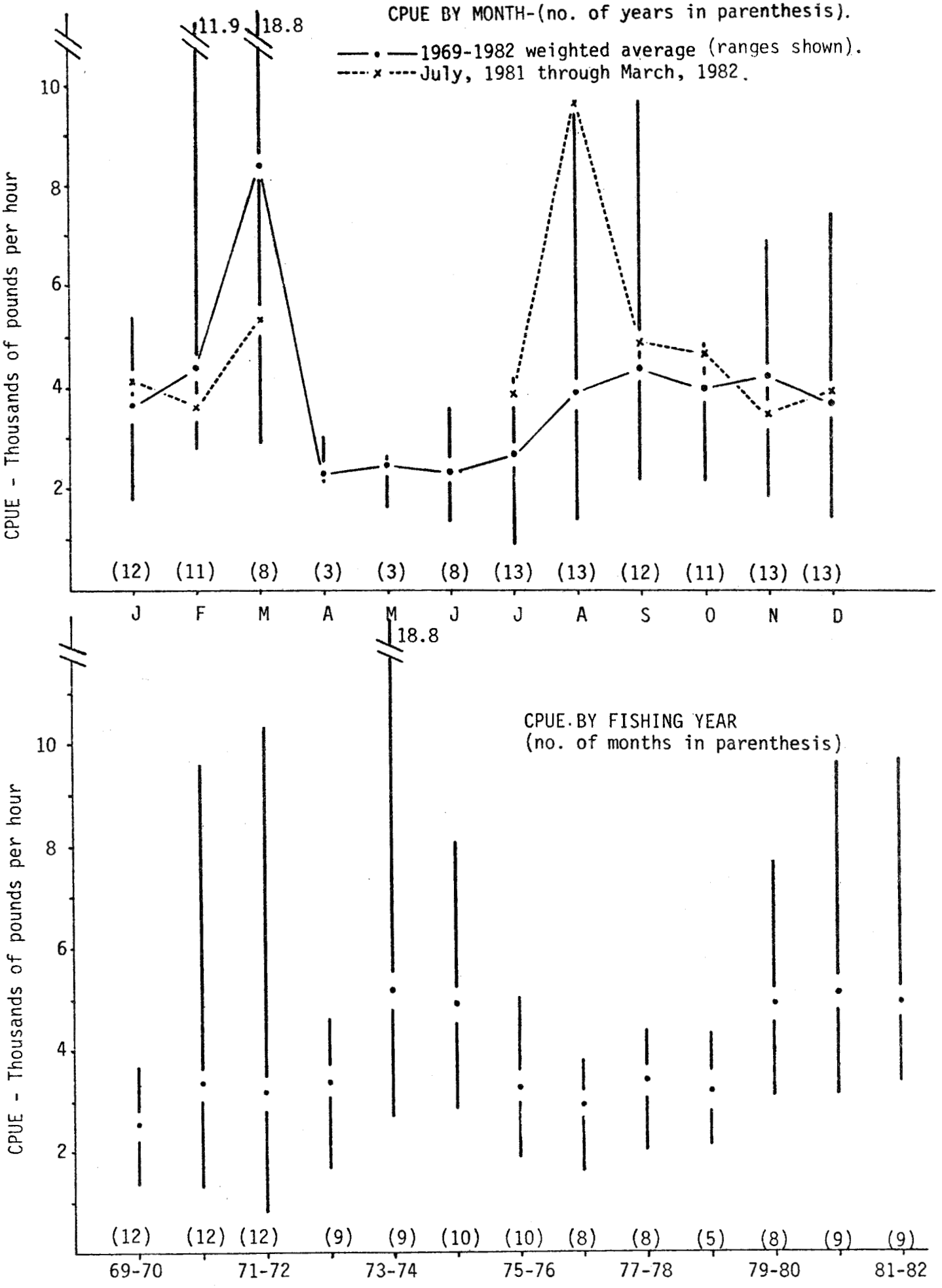


Figure 8 . Weighted average CPUE by month and by year. Ranges shown.

vertical line. Catch per unit effort levels normally were lowest in the summer months when shrimp were scattered. The highest values occurred during February and March when the shrimp were concentrated prior to egg release time. During the 1981-82 season, also shown in the upper graph in Figure 8, CPUE levels were above average during the summer months and reduced in the late fall and winter.

A comparison of June to August CPUE values and May research estimated abundance indices is plotted on Figure 9. These data indicate that a fair relationship existed at least until 1979. The 1980 and 1981 ranges indicate that the commercial trawlers were either more efficient than previous years, or that the abundance index surveys were underestimating the shrimp biomass. Considering the changes that have occurred in the fishery the past 3 years it is assumed that the commercial vessels have become more efficient. With these facts in mind, CPUE comparisons between recent years and historic data should be viewed with caution.

Vessel Description and Gear

Vessels and gear engaged in the Lower Cook Inlet trawl shrimp fishery remained relatively constant through the 1970's. A typical vessel was in the 50-80 ft (15.3-24.4 m) class and fished a single otter trawl similar to Figure 10. These otter trawls were 60-100 ft (18.3-30.5 m) wide at the foot rope.

Three individual boat skippers have remained in the fishery since 1970. These three skippers have all changed vessels through the years. Table 5 lists vessels making deliveries during the 1979-80, 1980-81, and 1981-82 seasons in the trawl shrimp fishery of the Southern District. The number of vessels increased from 7 in 1979-80 to 22 in the 1981-82 fishery. The average size decreased from 55.9 ft (17 m) in 1979-80 to 46.9 ft (14.3 m) in 1981-82 as smaller vessels entered the fishery. The majority of boats used single rig otter trawls. One vessel utilized double rig otter trawls and several smaller boats fished with plumb staff beam trawls.

Processing Characteristics

Through the 1978-79 fishing season the majority of the catch was landed in Homer and processed by mechanical peeling machines at the single processing facility. As ex-vessel prices and market demand increased, landings of Lower Cook Inlet trawl shrimp diversified to different markets. During the 1979-80 season a portion of the catch was shipped to Oregon for peeling. Several vessels hauled their shrimp to Kodiak; however, one vessel sank while enroute.

During the 1981-82 season all of the shrimp were landed in Homer. Mechanical peeling of the product was conducted at plants in Homer and Anchorage. Anchorage shrimp were transported by refrigerated truck/trailer to the processing facility which operated two peeling machines. The facility in Homer operates eight Laitram brand PCA shrimp peelers. Each peeler has a capacity of 5-600 lb (23-272.4 kg) per hour with a daily total capacity for the eight peelers of about 75,000 lb (34,050 kg) based on two shifts.

The shrimp are cooked from 1-2 minutes in steam prior to the actual peeling. After the shrimp meat has been removed from the shell the meat is graded as

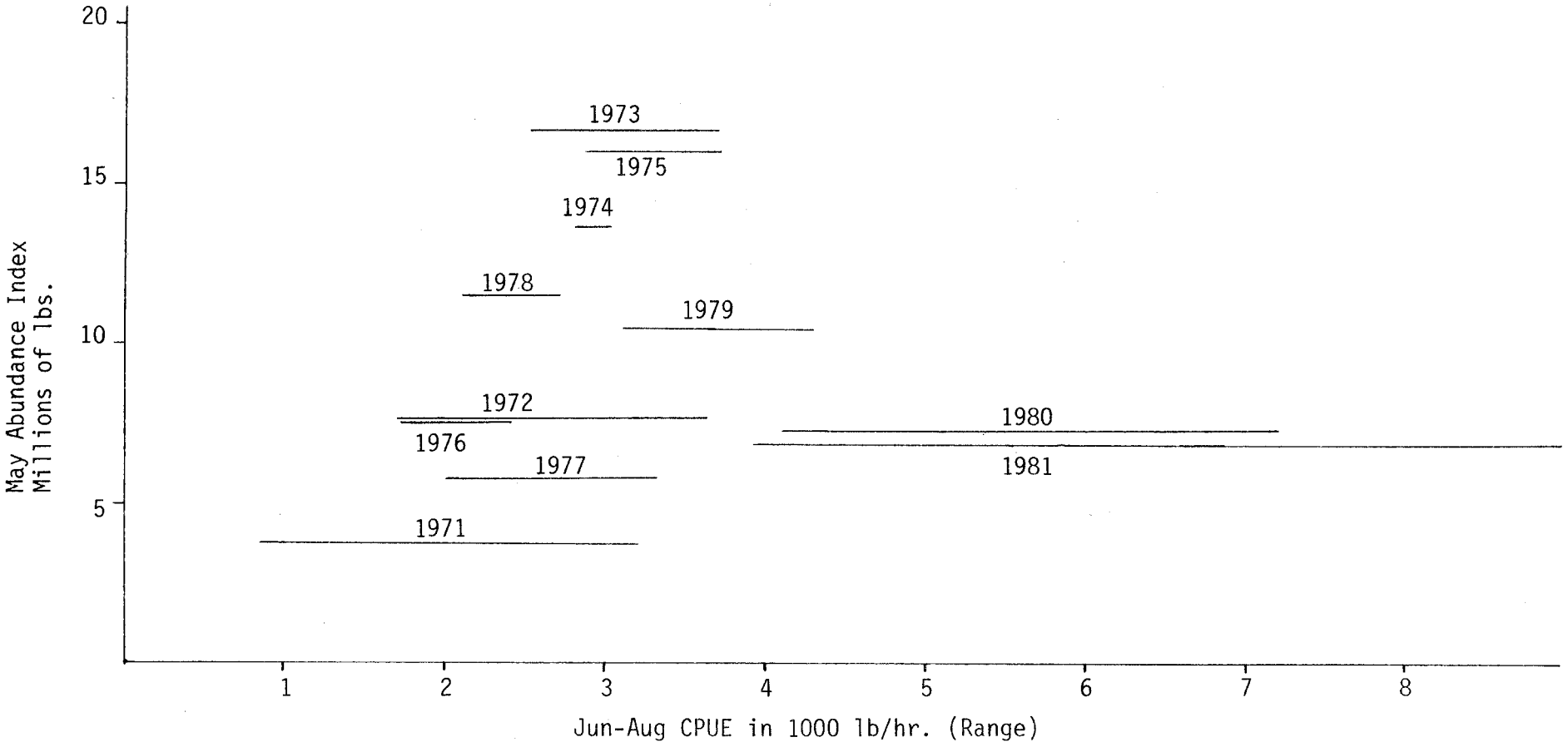


Figure 9 . Range of CPUE values from commercial trawl vessels and research survey index for the Southern District of Cook Inlet.

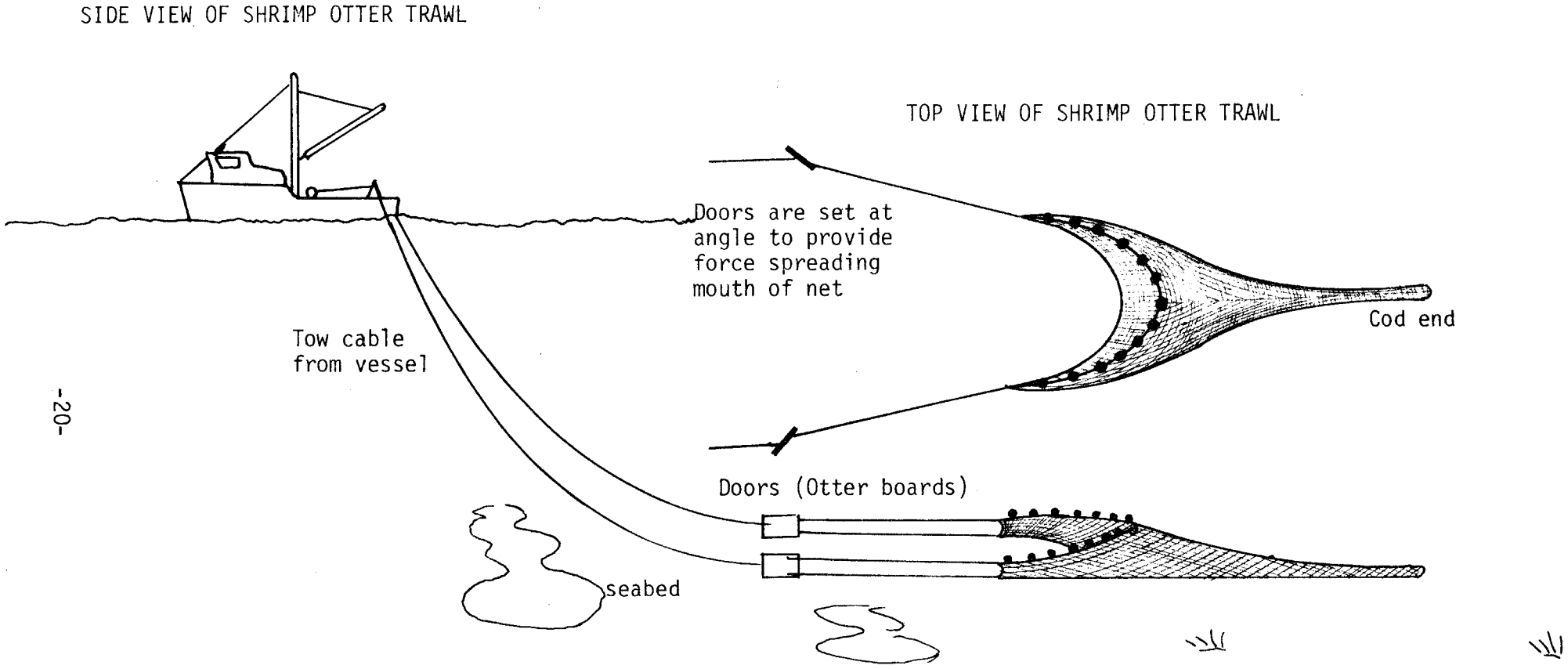


Figure 10. Schematic drawing of single rigged otter trawl.

Table 5. Trawl shrimp vessels making deliveries during 1979-80, 1980-81, and 1981-82 seasons in the Southern District.

Name	ADF&G Number	Tons	Length	H.P.	Trawl Net Type Otter	Beam
1979-80						
Columbian	15787	55	48	450	X	
Nightwatch	23565	49.6	46	365	X	
Moriah	17392	72	75	360	X	
Mylark	06334	28	50	130	X	
Sunrunner	36869	52	49.6	350	X	
Big Valley	23460	115	81.5	700	Double-Rig	
Tylene	18202	20	48	200	X	
AVERAGE		55.9	56.9			
1980-81						
Monarque	20369	5	32	230	X	
Cape Chacon	15652	29	42	165	X	
Sunrunner	36869	52	49.6	365	X	
Moriah	17392	82	68.8	425	X	
Nightwatch	23565	55	59.6+	365	X	
Big Valley	23460	115	81	700	Double-Rig	
Tylene	18202	20	48	200	X	
Carol Mary	15787	71	65	455	X	
Tiki	36357	17	41	250	X	
Moccasin	11258	10	32	200	X	
(Tida)	31166	11	32	260		X
(Taurus) voided	08005	5	30	100		X
Lobo Delmar	32845	11	36	660	X	
Miss Arctic	06120	21	44	165	X	
Vivienne II	18202	81	72	450	X	
Tonga	06095	6	28.6	130	X	
Violet	11897	37	60	200	X	
Irish Mist	31308	14	40	200	X	
Auriga	37722	15	36	225	X	
AVERAGE		34.6	47.2			
1981-82						
Carol Mary	15787	71	65	455	X	
Big Valley	23460	115	81	700	Double-Rig	
Crevette	42069	34	49	225	X	
Cape Chacon	15652	29	42	165	X	
Monarque	20369	5	32	230	X	
Vanguard	39946	159	85	940	X	
Anita	41244	16	47.3	165	X	
Eileen	39434	14	46.6	165	X	
Sea Mist	36358	29	50	285	X	
Tiki	36357	17	41	250	X	
Nightwatch	23565	55	59.6+	365	X	
Tylene	18202	17	41	250	X	

-Continued-

Table 5. Trawl shrimp vessels making deliveries during 1979-80, 1980-81, and 1981-82 seasons in the Southern District - continued.

Name	ADF&G Number	Tons	Length	H.P.	Trawl Net Type Otter	Beam
1981-82 - continued						
Bonanza	00019	40	42	165		X
Moriah	00018	82	68.8	425	X	
Kuleana	39695	15	30	280	X	
Lobo Delmar	32845	11	36	660	X	
Tonga	06095	6	28.6	130	X	
Tida	31166	11	32	260		X
Tortuga	20416	17	42	165		X
Northwind	28363	11	36	320	X	
Bronivik	15305	11	36	170	X	
Irish Mist	10903	14	40	200	X	
AVERAGE		35.4	46.9			

to size and placed in either 1 or 5 lb (0.5 or 2.3 kg) plastic bags. The shrimp meat is quick frozen.

Value of Catch

The ex-vessel value of the yearly harvest from 1969 to present is listed on Table 6. This table lists the annual catch in pounds, and estimated ex-vessel value of the product. The value has ranged from a low of $83,000 in 1969 to a high in 1980 of 1.8 million dollars. During this same time period the price per pound of shrimp has ranged from 4.5¢ to 29¢ during 1980. The price per pound during 1981 was lowered because of a higher than average amount of incidental fish species in the harvest. The Homer-based cannery was forced to employ additional personnel to sort fish from the shrimp.

Total Manpower Employed

It is estimated that about 55-60 persons were involved in the harvest of trawl shrimp in Lower Cook Inlet during the 1981-82 season. Employment at the Homer-based cannery was about 90 persons during any one processing day based on two shifts for the peeler operations. The Anchorage facility reported 25 persons were employed.

Interaction Between User Groups

Increasing conflicts are occurring between the mobile trawl shrimp fishery and the stationary gear fisheries for both shrimp and crab. Effort levels in the pot shrimp and crab fisheries have increased in recent years and during peak effort periods of the various seasons the number of pots in the bay makes it very difficult for trawl shrimp fishermen to find areas where trawling can be conducted without snagging on shellfish pots. In most cases trawl shrimp fishermen make every attempt to stay away from the gear because of the difficulties of removing pots from the large otter trawls. In order to minimize the number of conflicts betwen the two fisheries, (mobile and stationary gear) the opening dates have been adjusted for the different fisheries when possible.

BIOLOGICAL AND ENVIRONMENTAL DESCRIPTORS

Environment of Kachemak Bay

The Lower Cook Inlet area was proposed for oil exploration lease sales in the mid-1970's. In preparation for these sales, many varied studies were conducted in the Kachemak Bay area by State, Federal, and private agencies concerned with the marine environment.

A relatively concise description of Kachemak Bay was published by Science Applications, Inc. (1977). The Bay is partially separated into inner and outer regions by the Homer spit. The inner bay is characterized by relatively quiet waters with organic-rich bottom sediments. The outer bay substrate is more variable with some boulders and cobbles in the nearshore areas changing to silts and sands in the center of the bay.

Table 6. Price per lb and estimated total ex-vessel value of trawl shrimp harvested from Lower Cook Inlet 1969 to present.

Year	Price per lb	Annual Catch lb (thou)	Total Ex-Vessel Value $ (thou)
1969	.045	1,850	$ 83
1970	.05	5,808	290
1971	.045	5,395	270
1972	.05	5,377	269
1973	.075	4,550	341
1974	.095	5,064	481
1975	.07	4,526	317
1976	.095	5,769	548
1977	.135	4,642	626
1978	.165	7,186	1,186
1979	.225	4,070	916
1980	.29	6,144	1,782
1981	.27	5,031	1,359

Water circulation patterns are shown in Figure 11. Two gyres are located in outer Kachemak Bay, the clockwise rotating gyre is probably consistent, while the counter-clockwise current varies with the winds and tides. Gyres also occur in upper Kachemak Bay. Data suggests that upper bay waters may recirculate for sometime before flowing out.

High primary productivity values exist in the Bay area. This is the result of clear Gulf of Alaska water mixing with seasonal runoff from the wetlands. High plankton production is supplemented by rich macrophyte assemblages and kelp beds. Organic detritus is contributed by the kelp beds and wetlands.

Haynes and Wing (1977) of the National Marine Fisheries Service (NMFS) discuss the larval distribution of pandalid shrimp. Plankton tows were made semi-monthly beginning in late March and extending through June 1972 on 24 stations systematically spaced throughout inner and outer Kachemak Bay. Pandalid zoeae were first observed in the catches in early April with peak abundance occurring in May and June.

During 1976, further plankton sampling was conducted in Kachemak Bay and Lower Cook Inlet in a joint study by ADF&G and NMFS to determine if Kachemak Bay is a "closed system" in regard to whether shellfish larvae are carried into or out of the bay. The 1976 study did not fully answer the "closed system" question as some larvae were carried out of the bay both to the north and southwest. The amount of the stock carried out appeared small compared to the portion retained in the bay. Haynes suggested that more intense sampling over a larger area would be necessary to answer the "closed system" question (Haynes 1976).

During the environmental studies of Kachemak Bay and Lower Cook Inlet in 1976, Crow (1977) of Rutgers University studied the food habits of three species of shrimp. Pink, coonstripe, and sidestripe shrimp were examined from April through October and stomach contents identified. He determined that the stomach contents included amorphous organic matter (detritus) and algae, diatoms, and fragments of macro-algae. In addition, the stomachs contained substantial amounts of invertebrate parts and grit. He also assumed that since these items did not contain protoplasm that they probably were of secondary importance as an energy source. His results indicated that shrimp are injecting matter at or near the bottom since plankton samples taken concurrently with the shrimp samples did not correspond with the shrimp stomach contents. The study also concluded that most of the diatoms and some of the macro-algae found in the stomachs were associated with the marsh mudflat areas that are well represented in the Kachemak Bay area.

Life History Features

Barr (1970) discusses the life history of Alaska's commercially important species of shrimp including pink shrimp life history from Kachemak Bay since much of the information originated from studies in Lower Cook Inlet by the Bureau of Commercial Fisheries (now NMFS). Since the life histories of the commercially important species of shrimp in Alaska are all similar, the pink shrimp was used as an example because most research has been devoted to this species. The developing eggs of pink shrimp are carried on the abdominal appendages of the females for about 6 months and hatch in March or April. The newly

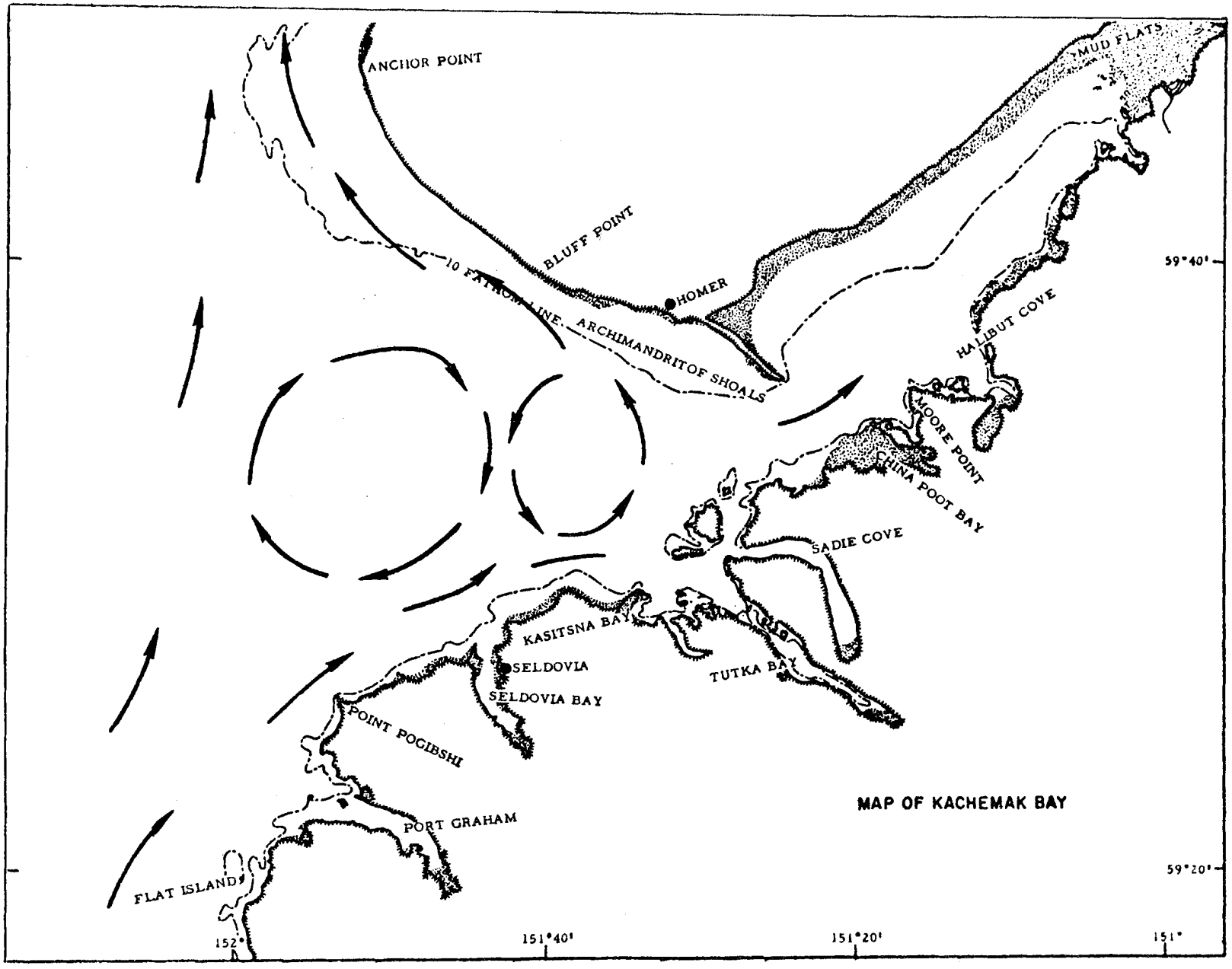


Figure 11. Generalized circulation pattern in Kachemak Bay (Haynes and Wing, 1977).

hatched shrimp, known as larvae, are about 3/16 in (5 mm) long and are entirely different from the adults. The planktonic larvae drift passively or swim weakly at midwater depths where they feed on organisms smaller than themselves. During the first 2 or 3 months after they hatch, the larvae molt (shed their outer skeleton or shell) about six times. With each molt they grow larger and become more like the adults in appearance. By early summer the larvae closely resemble the adults, although they are still less than 3/4 in (19 mm) long. As they change to the adult body form, they leave the plankton and take up the adult style of existence - standing or walking on the bottom or swimming above the bottom.

In Kachemak Bay, pink shrimp live at least 5 or 6 years, but most of their growth is completed in the first 4 years. With a few possible exceptions, the shrimp are males from the larval stage through their third or fourth year of life, but in the fourth or fifth year they transform to females. This change of sex, which is typical of the sexual development of most pandalid shrimp, occurs gradually as the animal goes through several molts. The transformation begins about March or April and may not be complete until August or September. Once the sex change is complete the individual remains a female the rest of its life. The result is a breeding population that normally has several age groups or shrimp, of which the younger are males and the older are females.

Spawning usually begins in late September and ends in mid-October. The males do not undergo any major external change during the reproductive season, but just before spawning the female molts into a shell specialized for carrying the eggs. A female in spawning shell has setae (hair-like structures) on the abdominal appendages which are longer and plates on the sides of the abdomen which are deeper than those of a nonspawning female. Soon after the prespawning molt of the female, the shrimp mate and the eggs are deposited. The male attaches a packet of sperm on the underside of the female, where the eggs will be fertilized. As the female extrudes the eggs through a pair of openings at the base of a pair of legs, the eggs are carried backward and attached to the setae on her abdominal appendages, where they are protected by the deep lateral abdominal plates. Fertilization takes place as the eggs pass across the sperm packet on their way to the abdominal appendages. The developing eggs remain attached to the setae until they hatch. Large females may produce 2,000 or more eggs at one spawning. The female does not molt or grow in the 5 to 6 months needed for the eggs to complete development and hatch, but about 2 weeks after the eggs hatch she molts and returns to her nonbreeding-type shell.

The eggs are still attached to the female when they hatch. During the hatching of her brood, which may take up to 2 days, the female stands on the bottom and vigorously "fans" the water with her abdominal appendages at intervals of several minutes. During each "fanning" the larvae which hatched during the preceding few minutes are washed from the egg cluster by the water current and drift away. The shrimp are now on their own.

TRAWL INDEX SURVEYS

Methods

The NMFS initiated a shrimp trawl index survey program in the Southern District of Lower Cook Inlet beginning in the spring of 1971. The surveys were taken over by the ADF&G in 1974. From 1971-74 the net used in the surveys was a 66 ft (20.13 m) head rope width Nordby net. Based on comparative tows, the Nordby net was assumed to be 50% as efficient as the 61 ft (18.6 m) high opening net used in the surveys from 1975 to present. This trawl uses three 10 fm (18.3 m) dandy lines, the center one is attached to a rib line which is tied along the side of the high rise net. The trawl is held open by Astoria V-doors, 7.5 x 5 ft (2.3 x 1.5 m) in dimension. Two chains are attached along the foot rope, a 56 ft (17 m) tickler chain, and a 60 ft (18.3 m) trawl height regulating chain.

Tows are conducted over a 1-mile distance requiring a travel time of approximately 30 minutes. This bottom speed is about the same speed as commercial shrimp trawlers use in Kachemak Bay. Fishing is conducted in daylight hours during moderate tide series in May and October annually. Tows are made on a compass heading of 29° or 209° at the discretion of the vessel skipper.

Selection of fishing stations is conducted by gridding-off [1 mi^2 areas (1.61 km^2)] that portion of the Bay with a depth greater than 20 fm (36.6 m). Non-trawling areas near the end of the spit and in the vicinity of Yukon Island, Hesketh Island, and Barabara Point have been eliminated from the surveys because of underwater cables and mud. The fishable area of the Bay is divided into three sections: (A) above the spit, (B) between the end of the spit and Seldovia Bay, and (C) west of Seldovia Bay (Figure 12). Area B is the most productive commercially, therefore, the most intense sampling is conducted in this area. Approximately 55 mi^2 (28.6 km^2) is located in section B so 28 tows were selected randomly for sample fishing. In Area C, west of Seldovia, three tows were completed in the approximately 11 mi^2 (17.7 km^2) area. In Area A, nine stations were sampled in the 22 mi^2 area.

Towing has also been conducted in the Sadie Cove-Tutka Bay area but catch information is treated separately from the index towing areas in Kachemak Bay.

The catch is brought aboard the vessel and the cod end weighed by electronic scale. After dumping, all large non-shrimp objects are removed from the catch and returned over the side. Weight estimates of the objects are recorded. Two bucket samples comprising approximately 4 gal (15.2 liters) of shrimp are sampled from the catch if the total exceeds 500 lb (227 kg). For catches less than 500 lb, one bucket is sampled. Each sample bucket is separated by pandalid shrimp and other species and total weights obtained. A 2500 g (87.5 oz) sub-sample is collected from the pandalid shrimp and separated by shrimp species, weighed and recorded. The number of shrimp by species within the 2500 g (87.5 oz) sample is counted. A 1 pint (0.55 liter) sample of each species from each tow (if available) is collected and frozen for further length frequency analysis.

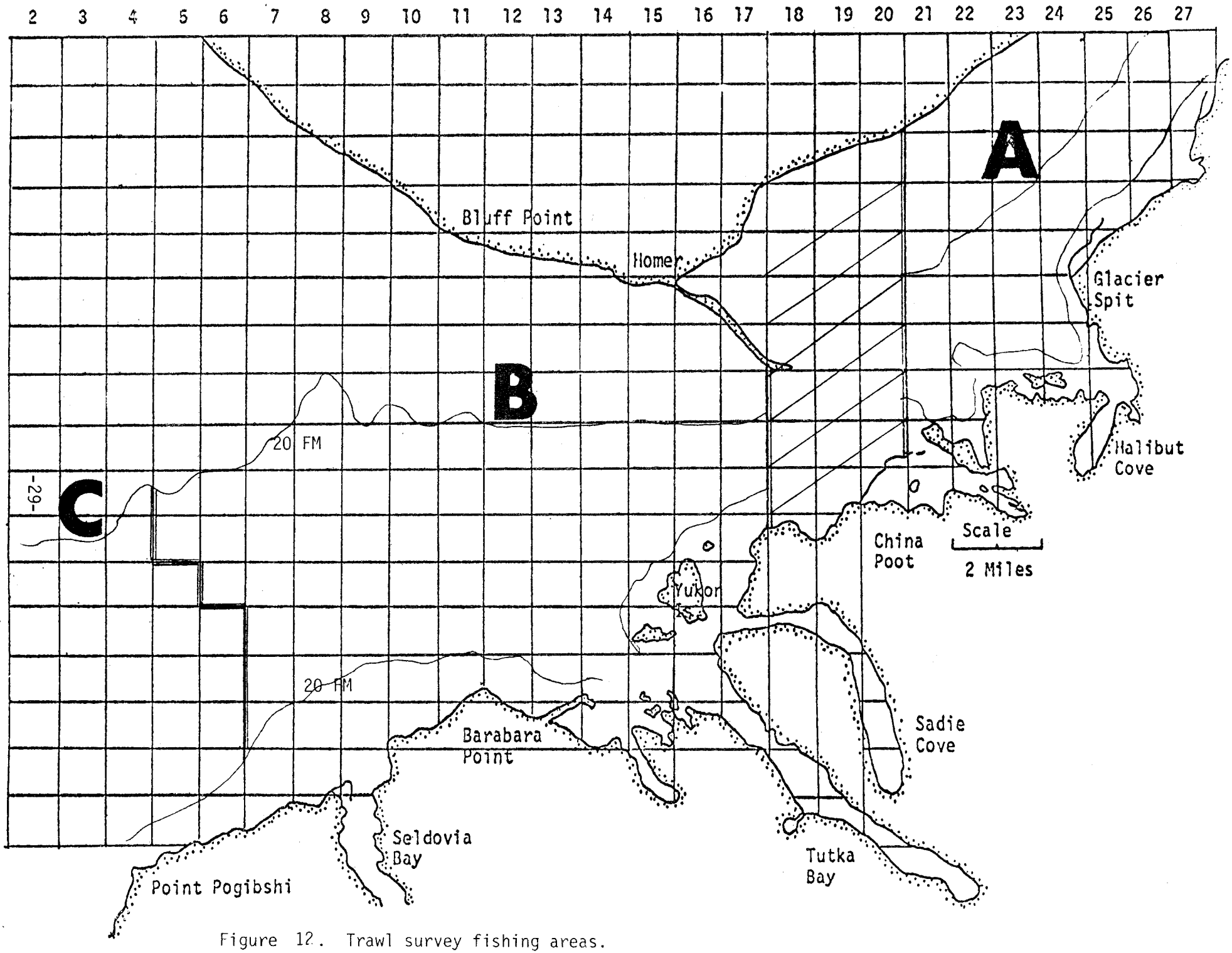


Figure 12. Trawl survey fishing areas.

Frozen samples are thawed, separated by sexual stage (males, females without sternal spines, and ovigerous females) measured to the nearest 0.5 mm (0.0195 in), and weighed. Carapace length measurement example is shown on Figure 13. All data is keypunched and analyzed by the shrimp trawl survey programs developed within the University of Alaska (U of A) computer system.

Trawl Index Results

A list of the trawl index survey abundance indexes is listed on Table 7. Spring indexes have ranged from a low of 3.7 million lb in 1971 to a high of 16.9 million lb during 1973. These data are graphed on Figure 14, and list the point estimate and range for each spring and fall survey. Two peak population abundances have occurred in the 11 years of sampling. The first peak occurred from 1973 to 1975 and the next increase happened during 1978 and 1979. Both of these peaks were associated with large increases in the humpy shrimp population. The species composition of shrimp captured in the index cruises is listed on Table 8. Humpy shrimp always comprised a higher percentage of the trawl survey in the fall as compared to the spring survey of the same year. On an overall basis, the most abundant shrimp has been the pink shrimp. The pink population appears more stable than the humpy shrimp population.

COMMERCIAL FISHERY SAMPLING

Methods

Catch sampling of the commercial fishery shrimp harvest is conducted during each fishing period. Two 1 gal (3.79 liter) samples are provided by alternate vessel skippers. These samples are taken both from an early catch and a later catch during the sampling period and picked up by the catch sampler at the end of the period. The shrimp are analyzed for species composition, weight, and length frequency. In addition, catch samples are collected from each vessel during unloading. These samples are analyzed for species composition, number of shrimp, and weight. The catch samples are analyzed by U of A computer services.

At the completion of the trawl index survey, the results are applied to the area-swept population estimate as follows:

$$\text{Mean shrimp catch} = \frac{\sum_{i=1}^{N} X_i}{N} = \bar{X}$$

Area - total area (Nm^2) considered = A

Total number of tows = N

$$\text{Sample variance } (SV) = \frac{1}{N-1} \sum_{i=1}^{N} (X_i - \bar{X})^2$$

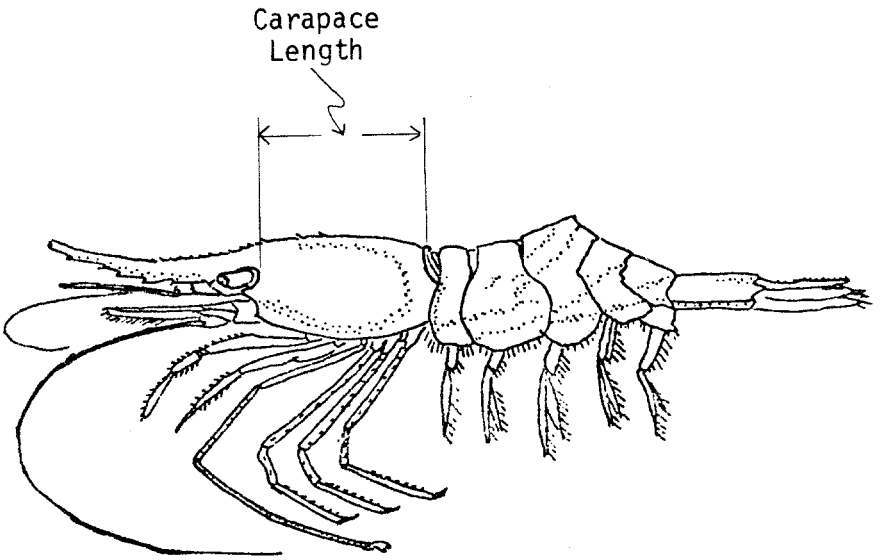


Figure 13. Carapace length measurement of humpy shrimp *P. goniurus* . This measurement is used for all species in Cook Inlet shrimp studies.

Table 7. Abundance index estimates of shrimp (millions of pounds) in the Southern District calculated from 1971 to present trawl surveys, based on pounds of commercial species of shrimp only.

Month	Year	Mean Catch	No. Stations	% Error	Abundance Index (Mill. of lbs.)	Range (Mill. of lbs.)	
May	1971	130.2[1]	56	20.0	3.708	2.966	4.450
May	1972	271.1[1]	66	35.5	7.721	4.980	10.463
May	1973	592.8[1]	59	27.8	16.883	12.189	21.576
Jun	1974	476.6[1]	30	22.8	13.575	10.480	16.670
May	1975	1,136.9[2]	37	27.9	16.190	11.673	20.707
May	1976	541.3	36	28.3	7.708	5.527	9.890
Jun	1977	407.9	40	17.1	5.808	4.815	6.802
May	1978	810.9	36	25.2	11.548	8.638	14.458
May	1979	743.7	41	20.9	10.591	8.378	12.805
May	1980	513.7	39	19.5	7.316	5.889	8.743
May	1981	486.1	37	18.4	6.923	5.649	8.197
May	1982	306.8	38	21.8	4.369	3.414	5.321
Oct-Dec	1976	719.8	33	21.6	10.250	8.036	12.464
Nov	1977	738.1	36	28.9	10.512	7.474	13.549
Oct	1978	1,160.3	32	25.5	16.524	12.310	20.738
Oct	1979	1,133.3	32	23.3	16.139	12.379	19.899
Oct	1980	1,689.4	37	19.3	24.059	19.415	28.702
Oct	1981	604.8	35	26.9	7.875	5.757	9.993

[1] 66' Nordby Net, 50% net efficiency.

[2] 1975 on 61' hi opening net, 100% net efficiency.

where $X_1, X_2 \ldots, X_N$ are the standardized (1 nm) catches of shrimp from each tow.

Standard deviation $(SD) = \sqrt{SV}$

Standard error of the mean $(SE) = SD/\sqrt{N}$

Population estimate $(p) = \frac{(6076 \times A)}{32} \bar{X}$

Standard deviation of the population estimate $(Sp) = \frac{(6076 \times A)}{32} SE$

Percent error = $\frac{1.3 \times SE \times 100}{X}$

Notes: 6076 is the number of feet in a nautical mile; 32 is the effective width in ft of the net; A is the area of the stratum, in square nautical miles; and $\bar{X}$ is the mean catch.

Percent error: 1.3 is the value from the Normal distribution statistical table giving an approximate 80% one-sided confidence interval.

Source: (Watson 1981)

The total catch of pandalid shrimp was expanded into number of individual shrimp by size by time period. Two methods of expansion were used for the data (Appendix Tables 5 and 6). The first method uses the number of shrimp per pound to establish the total number by species by time period. The second method separates the shrimp by size class and assigns weight by size based on a predetermined length-weight curve for the particular species.

Length frequency curves were drawn for each species as follows: Length frequency by number, length frequency by percentage, deviation of length from average number, and deviation of percentage from average percentage (Skuladottir 1979), and plotted for years 1970-71 through the 1980-81 commercial seasons.

Results

Commercial fishery sampling results are found under each subject category as follows: species composition, number of shrimp per pound, growth estimates, number of shrimp in catch, and length-weight relationships.

Species Composition:

Commercial harvest species composition is summarized by season on Table 9. Species composition by month is also listed in Appendix Table 7. During the 12 years of the fishery from 1970-71 to 1981-82, a total of approximately 62.5 million lb of shrimp were landed, of which 52.7% were pink, 38.9% humpy, 3.4%

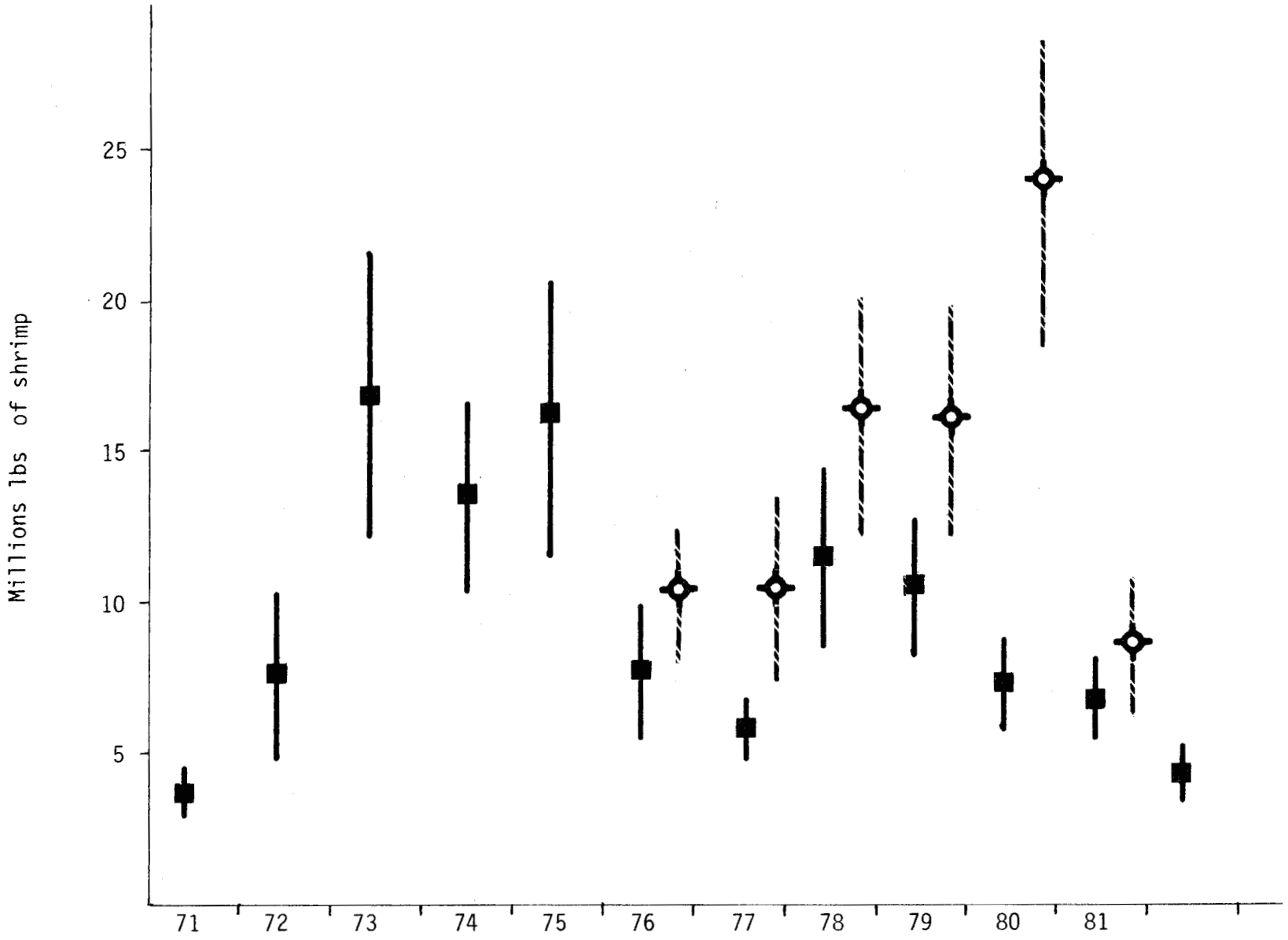


Figure 14 . Abundance index estimates of commercial species of shrimp (millions of lbs) in the Southern District calculated from trawl surveys, (square for spring surveys, circle for fall surveys).

Table 8. Catch composition (percentage) of index cruises and population abundance index by month and year.

Year	Month	Pink	Humpy	Coon	Side	Abundance Index (Million lb)
1971	May	83.8	9.9	1.9	4.4	3.708
1972	May	62.0	33.2	1.3	3.5	7.721
1973	May	67.5	27.3	1.8	3.4	16.883
1974	Jun	81.6	7.9	2.2	8.3	13.575
1975	May	74.8	16.6	2.7	5.9	16.190
1976	May	82.6	5.3	3.6	8.5	7.708
1977	Jun	83.4	3.3	6.1	7.2	5.808
1978	May	67.9	24.8	1.3	6.1	11.548
1979	May	78.3	14.3	2.3	5.1	10.591
1980	May	63.4	23.6	1.9	11.1	7.316
1981	May	72.7	13.8	4.2	9.3	6.923
1982	May	73.2	12.6	3.4	10.8	4.369
1976	Oct-Dec	69.0	20.8	3.0	7.2	10.250
1977	Nov	58.1	29.2	2.0	10.7	10.512
1978	Oct	47.4	45.9	1.7	5.0	16.524
1979	Oct	45.2	50.4	0.7	3.7	16.139
1980	Oct	57.8	34.5	1.5	6.2	24.059
1981	Oct	57.8	30.4	1.6	10.2	7.875

Table 9. Species composition of commercial harvests of shrimp in Kachemak Bay by the trawl shrimp fishery.

Years	Pink *P. borealis*		Humpy *P. goniurus*		Coonstripe *P. hypsinotus*		Sidestripe *P. dispar*		Total lb
	%	lb	%	lb	%	lb	%	lb	
1970-71	63	3,723,319	25	1,480,494	5	312,242	6	389,933	5,905,988
1971-72	63	2,846,666	29	1,300,657	5	217,717	3	155,866	4,520,906
1972-73	56	2,651,866	36	1,699,867	4	195,184	4	206,575	4,753,492
1973-74	41	1,949,952	56	2,678,080	3	131,079	1	46,521	4,805,632
1974-75	42	2,129,777	54	2,717,039	2	119,181	1	65,916	5,031,912
1975-76	45	1,967,454	44	1,947,541	3	145,072	8	358,942	4,419,009
1976-77	58	2,887,149	31	1,544,619	5	228,917	7	338,301	4,998,986
1977-78	65	3,272,468	23	1,178,616	4	193,056	8	393,806	5,037,946
1978-79	48	2,867,868	45	2,738,103	3	151,142	4	255,686	6,012,799
1979-80	50	2,895,511	43	2,497,423	2	143,526	5	260,966	5,797,426
1980-81	48	2,957,138	44	2,700,870	2	141,560	6	379,811	6,179,379
1981-82	55	2,762,101	36	1,791,001	3	120,781	6	321,616	4,995,499
TOTAL		32,911,269		24,274,310		2,099,457		3,173,939	62,458,974
PERCENT	52.7		38.9		3.4		5.0		

coonstripe, and 5.0% sidestripe shrimp. Figure 15 also graphs the percentage species composition by month for the years from 1970 to present. Pink shrimp are shown by horizontal lines in the lower portions of each graph. Humpy shrimp are graphed by vertical lines while the upper portion of each graph shows the percentage of coonstripe and sidestripe shrimp added together. During the first three seasons, (1970-71 to 1972-73) fishing occurred during every month. Spring closures were enacted and seasons were generally from mid-summer to late winter. During the 1973-74 and 1974-75 seasons the major species harvested was humpy shrimp. Generally speaking, humpy shrimp do not become available to the trawl gear until late summer or early fall and remain available until the end of the year at which time they appear to move out of the normal trawling areas. During the 1980-81 season, humpy shrimp moved into the Sadie Cove area in strength. A large percentage of the shrimp were ovigerous females.

Number of Shrimp Per Pound:

Catch sampling of the commercial harvest provides the average number of shrimp per pound by species. These data are listed for each fishing season from 1970-71 through 1980-81 on Table 10. Pink shrimp ranged from 110 to 141 shrimp per pound while humpy shrimp sizes varied from 93 to 158 per pound. Humpy shrimp sizes were largest during the mid-1970's when the peak humpy population occurred (93 per lb in 1975-76). Coonstripe shrimp delivered in the trawl fishery ran from 34 to 58 per pound. Coonstripe shrimp delivered from the commercial pot fishery were somewhat larger, ranging from 20 to 47 shrimp per pound with the majority less than 30 per pound.

Sidestripe shrimp delivered in the trawl fishery were somewhat smaller in size than coonstripes. Sidestripe size ranges averaged from 47 to 66 shrimp per pound.

Growth Estimates:

Olsen (1975) calculated a growth curve for pink shrimp in the Southern District of Cook Inlet based on data from NMFS trawl surveys and analysis of commercial catch sample length frequencies. These data are displayed in Figure 16. Carapace length frequency by percentage from commercial catch samples collected during October to March are graphed in Figure 17. The suggested growth increments from the Olsen data in Figure 16 are entered on each graph. As the year classes passed through the fishery, the peaks of growth corresponded reasonably well with the suggested growth for pink shrimp.

Humpy shrimp length frequencies for the October to March period are also graphed in Figure 17. Growth curves for humpy shrimp in Lower Cook Inlet have not been established. However, the pink shrimp growth appears to fit the humpy data reasonably well. Figure 18 has humpy shrimp carapace length frequency information graphed by three methods: length by numbers of shrimp, length by percentage, and the percentage deviation from the average percentage. These data are based on research trawl surveys conducted in the fall months. These data fit the suggested growth increment lines. The carapace length frequency of humpy shrimp sampled from commercial fishery deliveries are graphed in Figure 19. It is possible to follow strong year classes through the graphs.

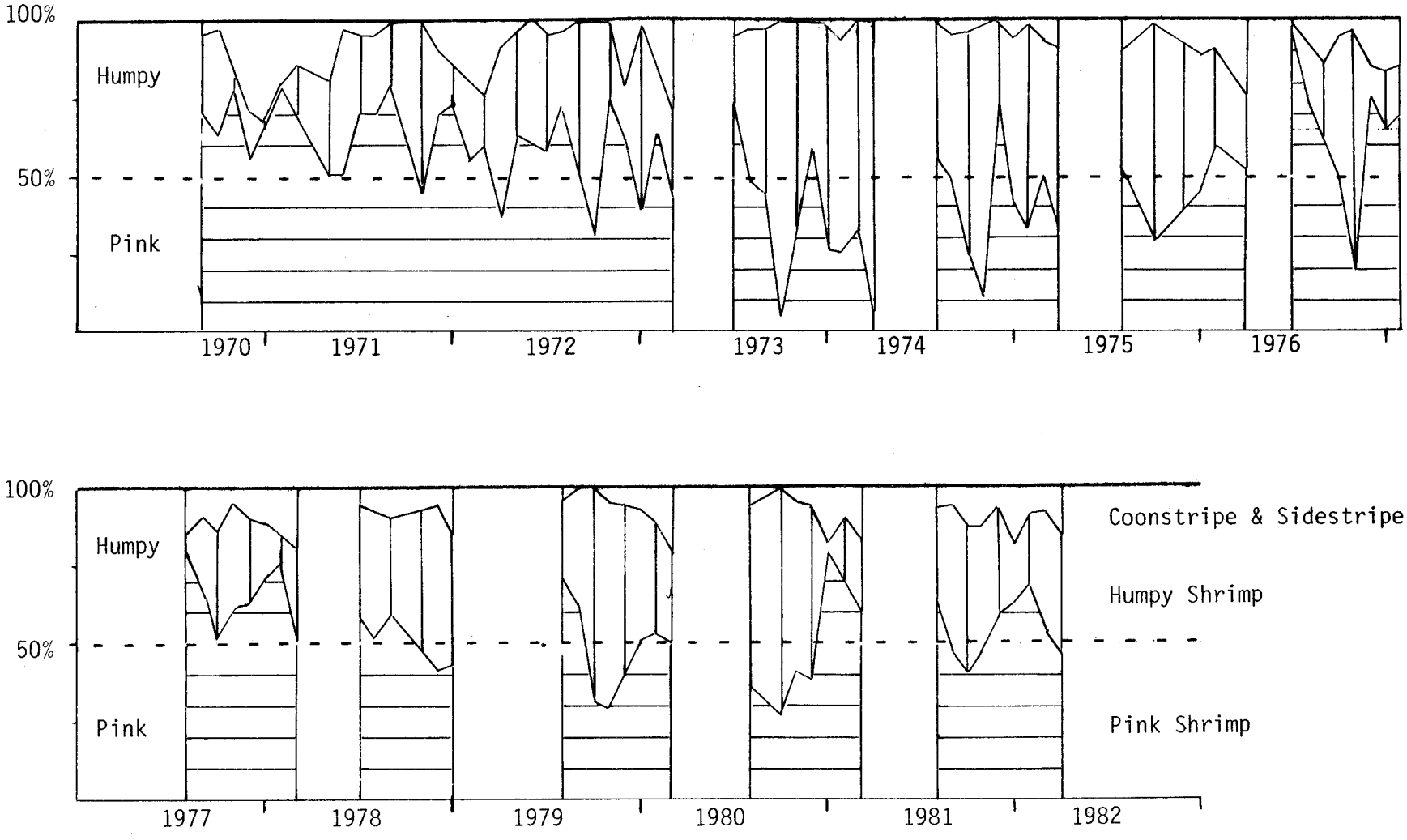


Figure 15 . Percent commercial harvest by species by month for the trawl shrimp fishery of the Southern District.

Table 10. Number of shrimp per pound by fishing season from commercial catch sampling based on number/lb weighting factor.

Season	Pink *P. borealis*	Humpy *P. goniurus*	Coonstripe *P. hypsinotus*	Sidestripe *P. dispar*
1970-71	135	131	36	49
1971-72	111	135	39	47
1972-73	119	136	34	55
1973-74	111	111	44	57
1974-75	110	96	34	52
1975-76	125	93	34	45
1976-77	118	122	34	48
1977-78	141	158	50	66
1978-79	121	131	58	53
1979-80	122	117	36	54
1980-81	114	118	34	47

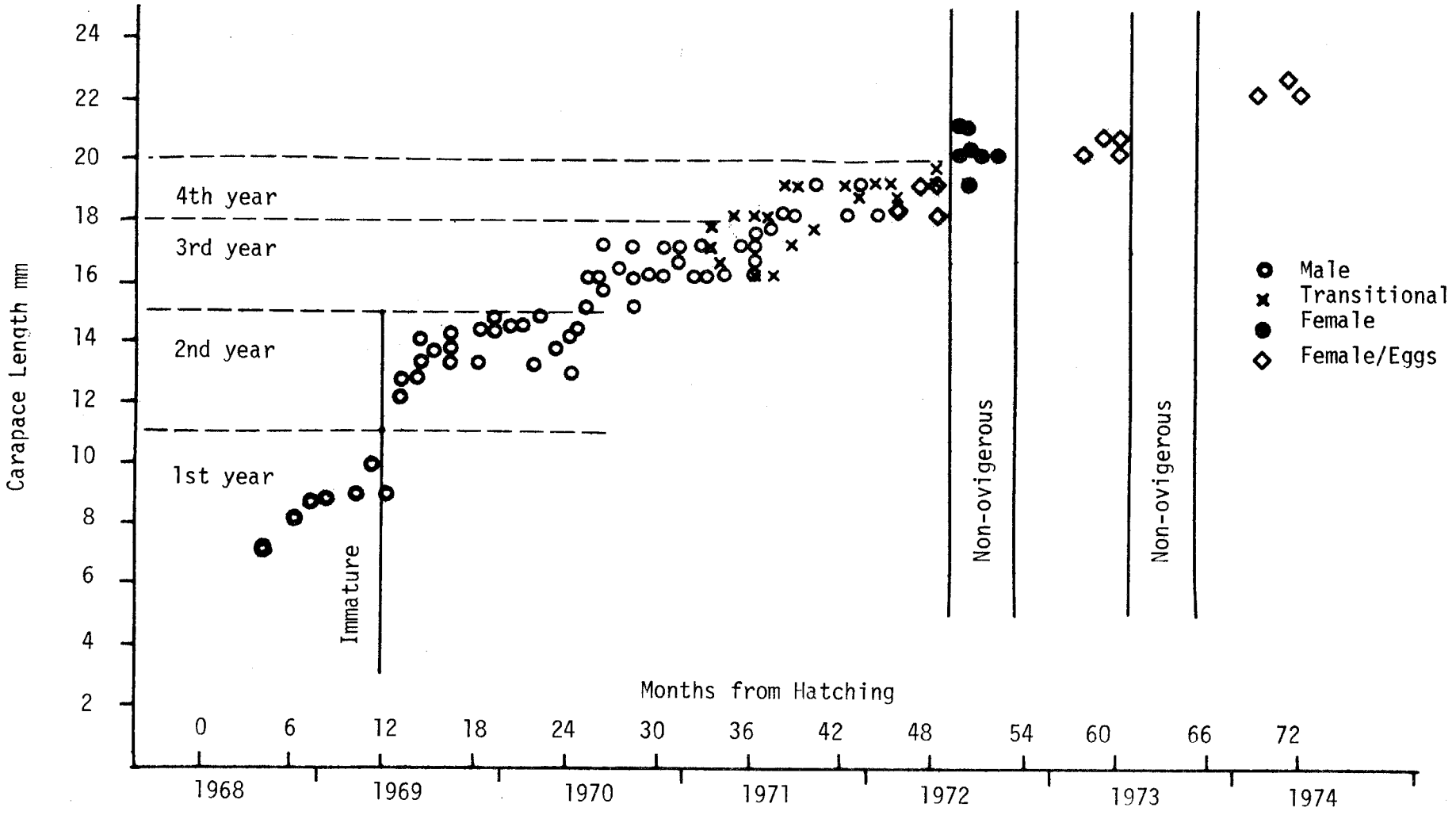


Figure 16. Pink shrimp *(P. borealis)* carapace length (mm) as a function of months from hatching from the 1968 year class (data from Olsen 1975).

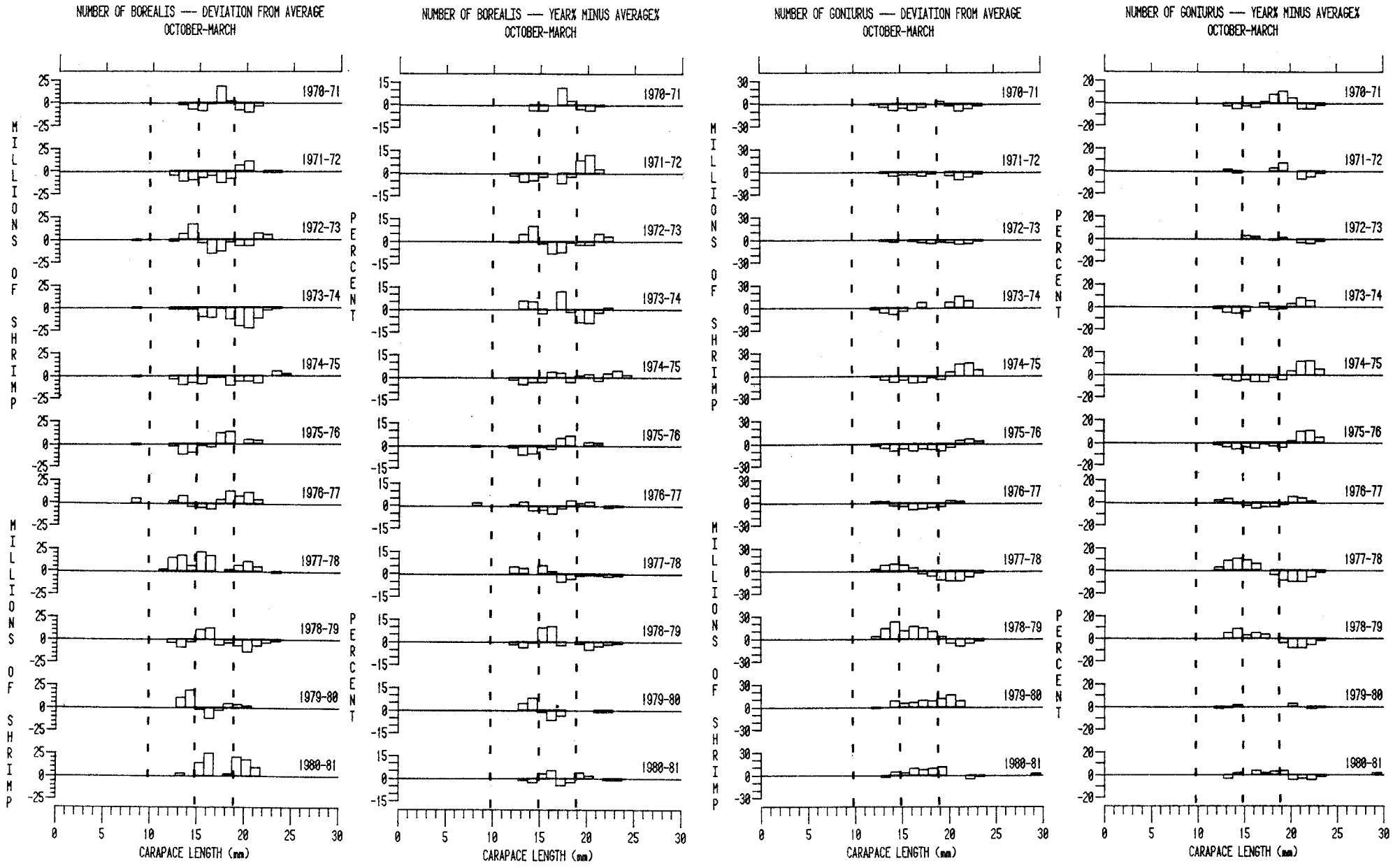


Figure 17. Carapace length frequency of pink shrimp, *P. borealis* and humpy shrimp, *P. goniurus* by the deviation method (Skuladottir 1979) for commercial samples collected from October to March.

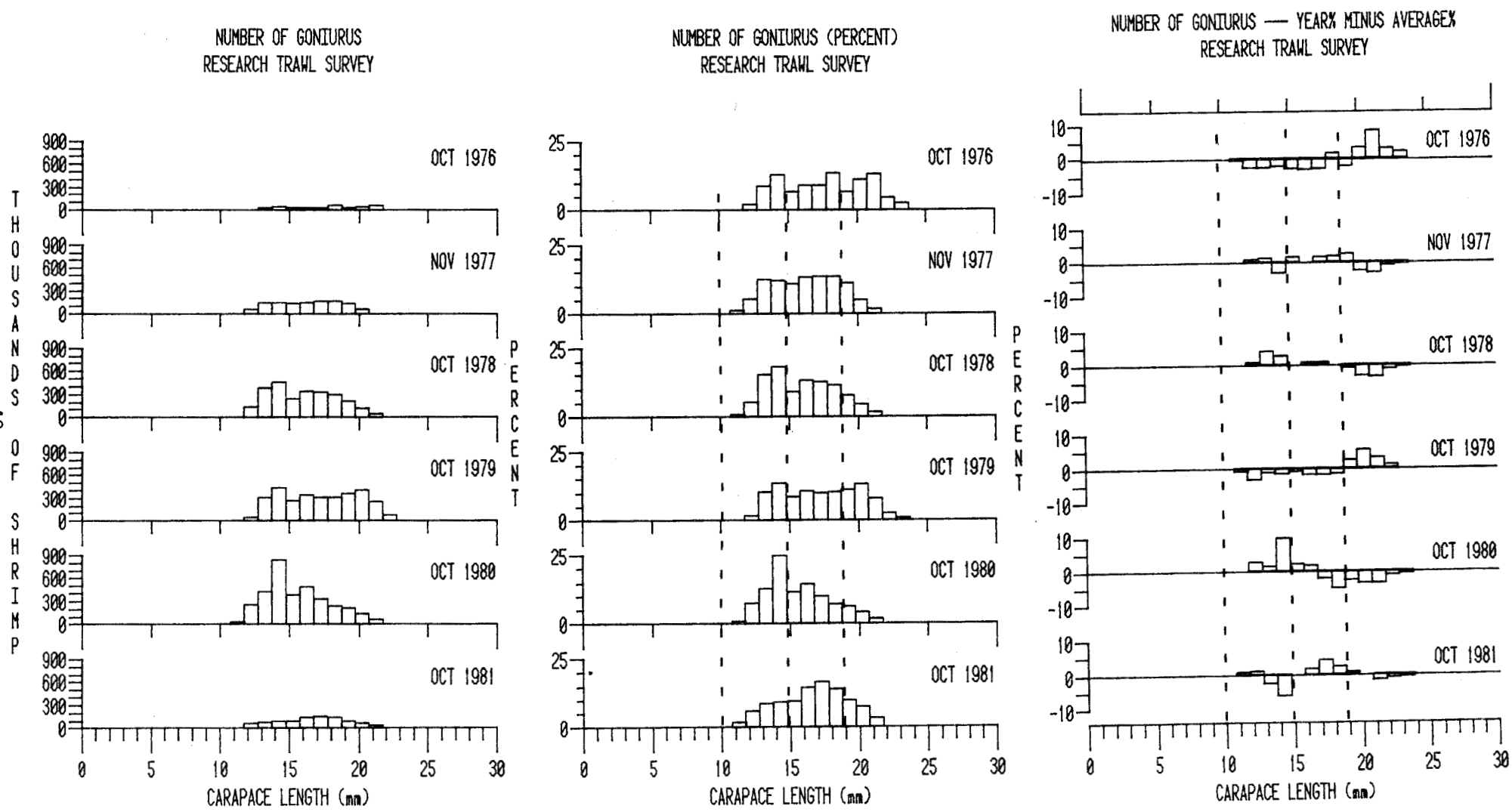


Figure 18. Carapace length frequency for humpy shrimp, *P. goniurus* sampled from fall research trawl surveys.

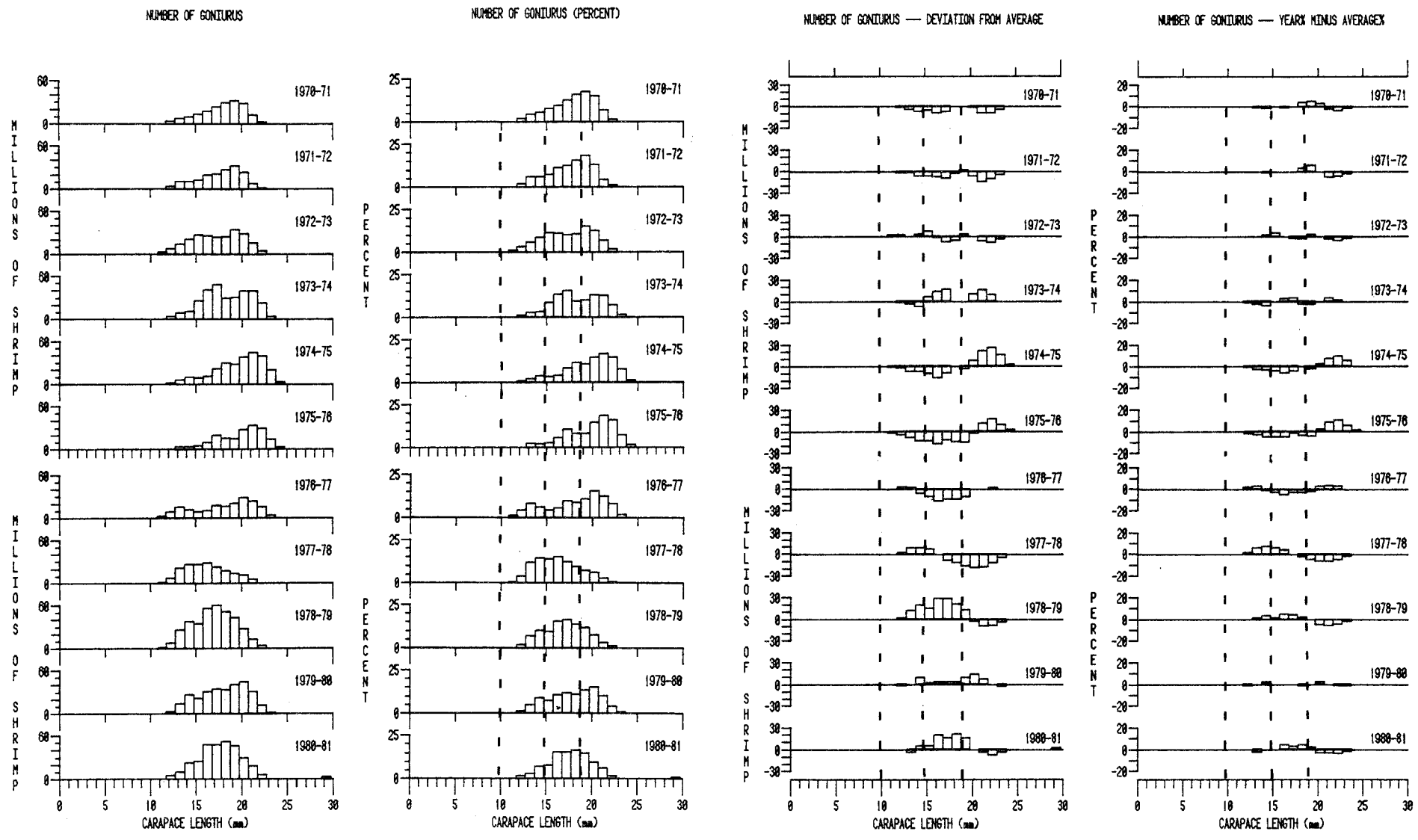


Figure 19. Carapace length frequency for humpy shrimp, *P. goniurus* sampled from commercial catch deliveries.

A good example is found on the "Deviation of Average" graph. The 1970 brood year was abundant and showed up as age II's in 1972-73 in the 10.0-14.5 mm size group. During 1973-74, the group showed up in the 15.0-18.5 mm increment. The following season (1974-75), the peak abundance occurred in the 19.0 mm and over (age IV+) group.

Growth estimates for coonstripe and sidestripe shrimp were obtained from the carapace length frequency graphs based on the research and commercial catch samples (Figure 20). These estimates suggest the upper and lower limits of the increments for each years growth. The length frequency graphs are found in Appendix Tables 8 through 11 and Appendix Figures 1 through 11. Growth increment lines were drawn on each graph to best fit the data. Some variation exists in the growth increments especially in the coonstripe shrimp graph. As further length frequency information becomes available, these data should be refined.

Number of Shrimp in Catch:

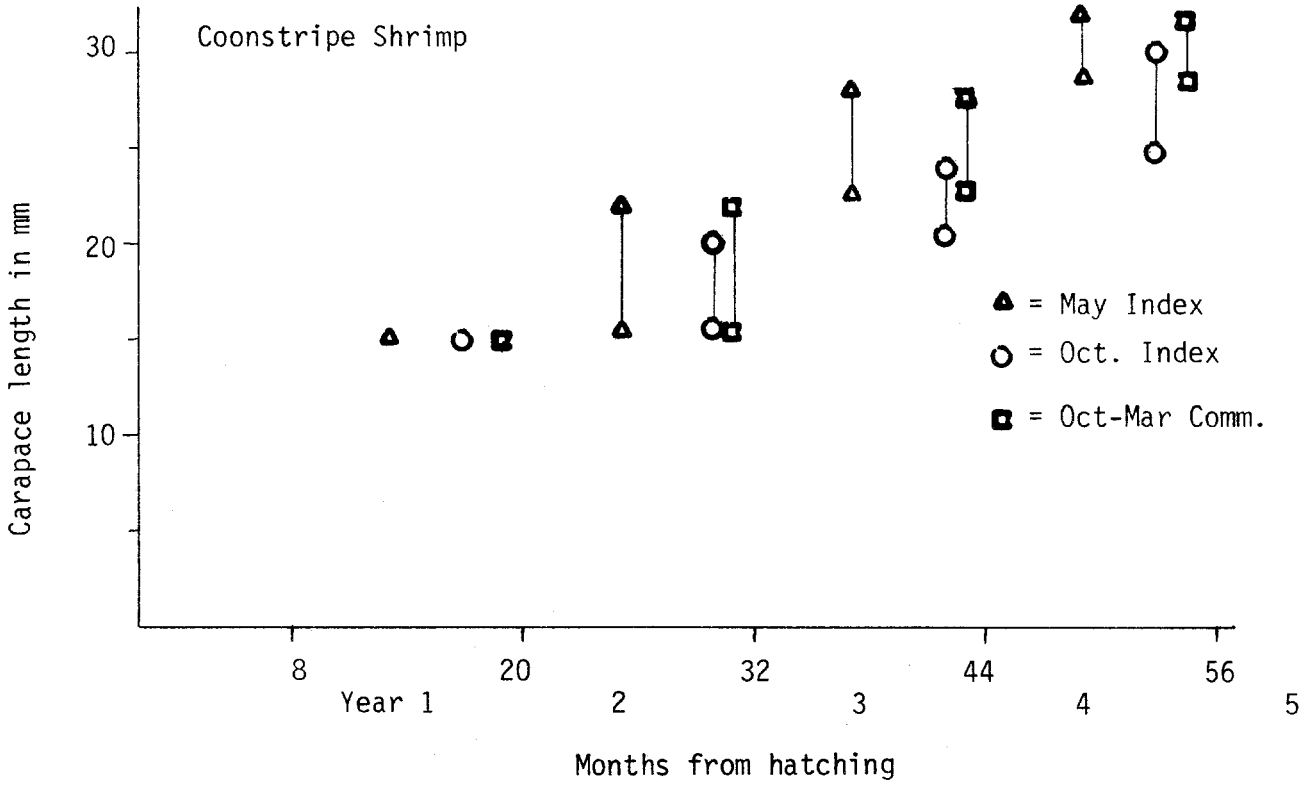
Sampling of the commercial fishery provided an estimate of the number of shrimp by size class by species in the harvest. The total number of commercially harvested shrimp during the 11 years of sampling from the 1970-71 season to the 1980-81 season is listed by species in Table 11. During the 11-year period an average of about 600 million individual shrimp per year were harvested with pink and humpy shrimp by far the dominant species at 355.2 and 244.1 million, respectively.

The number of shrimp by size class for pink and humpy shrimp, based on the growth estimates is listed in Table 12 for pink shrimp and Table 13 for humpy shrimp. Both pink and humpy shrimp are captured by the trawl gear in strength starting at age II and peaking in abundance at age III or IV. These tables are arranged to reflect brood year strength. For comparison purposes, the number of shrimp by size class captured during the spring index surveys is listed on each table. Since the number of tows for each survey was not consistent, the total number of shrimp by size class was divided by the number of tows for that year to indicate the number of shrimp per nautical mile.

The total number of pink and humpy shrimp by brood year for both the commercial fishery and spring trawl index surveys is plotted on Figure 21. These data suggest that strong year classes of both pink and humpy shrimp occurred during 1975 and for 1976. This corresponds with population abundance increase during the late 1970's.

Length-Weight Relationships:

In order to establish the number of shrimp by size, length-weight curves by month for each species were developed. Sampling was conducted each month that shrimp were available. Average weights for each 5 mm carapace length group were measured. Tables of the length-weight data are listed in Appendix Figures 12-19. The information for each species is graphed for two periods, May to October and December to March. These periods correspond to major non-egg bearing months and ovigerous months. To establish weight for a given carapace length the formula is as follows:



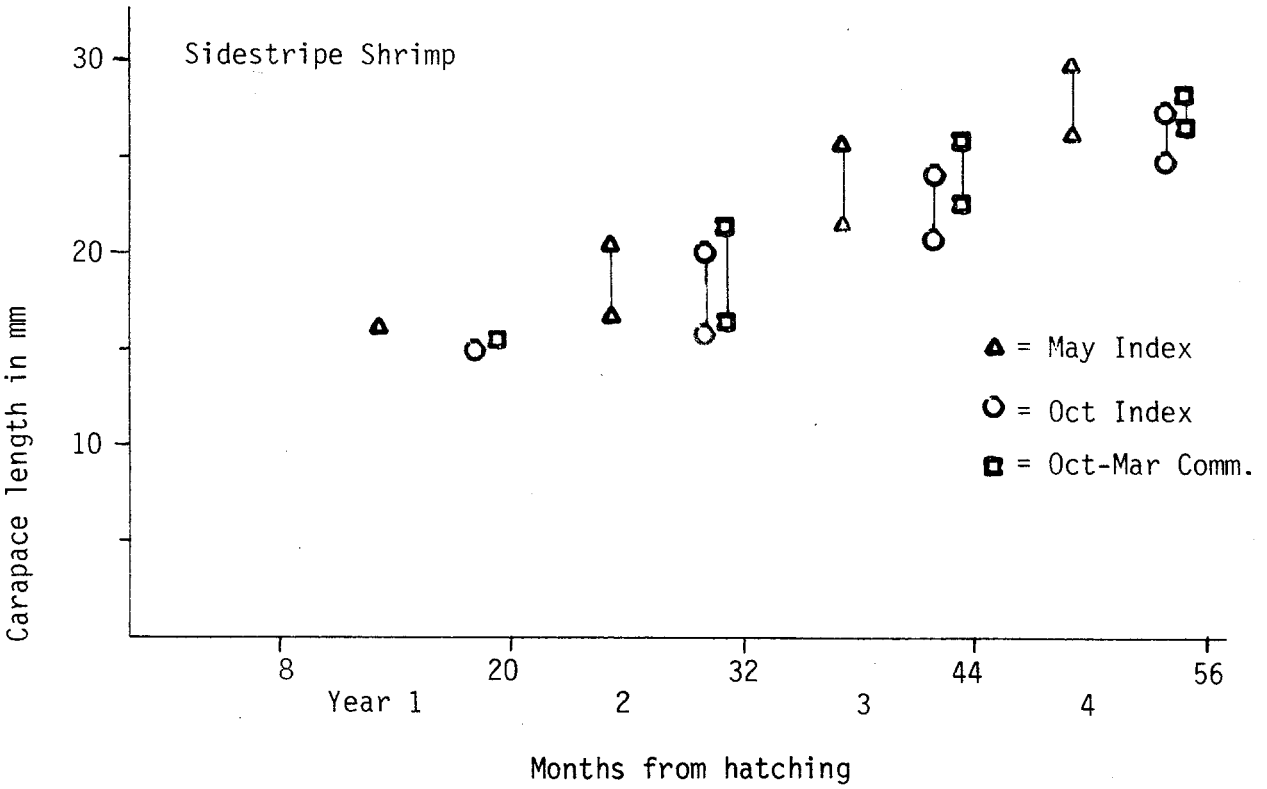


Figure 20. Growth information for coonstripe and sidestripe shrimp based on length frequency graphs from index and commercial fishing samples.

Table 11. Total number of shrimp by species in commercial harvest from 1970-71 to 1980-81 seasons (thousands of shrimp).

Species	Low number	High number	11-year average
Pink	226,854	492,342	335,195
Humpy	176,280	362,927	244,121
Coonstripe	4,200	10,782	6,984
Sidestripe	2,834	26,316	13,533
Totals	410,168	892,367	599,833

Table 12. Number of pink shrimp by size class based on number per pound weighting of the commercial fishery and index trawl survey of Lower Cook Inlet.

NUMBERS OF SHRIMP BY SIZE CLASS FROM COMMERCIAL SAMPLES IN THOUSANDS

Brood Year	I	II	III	IV	V	Total
1965					40,037	
1966				140,106	26,145	
1967			273,468	182,069	33,680	489,217
1968		37,818	96,323	116,932	42,231	289,304
1969	913	11,210	90,298	51,547	40,857	194,825
1970	1,188	63,081	90,357	84,038	22,360	261,024
1971	833	42,567	95,579	92,875	28,068	259,922
1972	152	15,324	126,608	145,308	23,480	310,872
1973	147	8,448	118,889	147,347	31,121	305,952
1974	134	49,842	182,755	113,771	27,141	373,643
1975	8,978	109,295	177,411	126,729	16,902	439,315
1976	1,979	25,942	117,097	135,833		280,851
1977	2,661	77,434	149,575			
1978	3,901	39,965				
1979	2,379					

NUMBER OF SHRIMP BY NAUTICAL MILE FROM SPRING INDEX IN THOUSANDS

Brood Year	I	II	III	IV	V	Total
1967				2.9	0.6	
1968			10.7	8.1	1.0	
1969		4.9	12.8	21.3	10.4	49.4
1970	0.1	2.1	15.4	12.2	20.2	50.0
1971	0.5	23.3	22.8	33.8	3.4	83.8
1972	1.0	4.5	59.9	18.3	3.2	86.9
1973	0.1	6.8	30.6	17.3	2.3	57.1
1974	0	5.9	15.3	23.7	4.8	49.7
1975	0.4	5.0	32.4	21.6	2.8	62.2
1976	0.3	15.2	44.7	13.0	2.0	75.2
1977	0.2	7.8	16.1	11.5		35.6
1978	1.2	7.8	25.0			
1979	0.3	9.5				
1980	1.8					

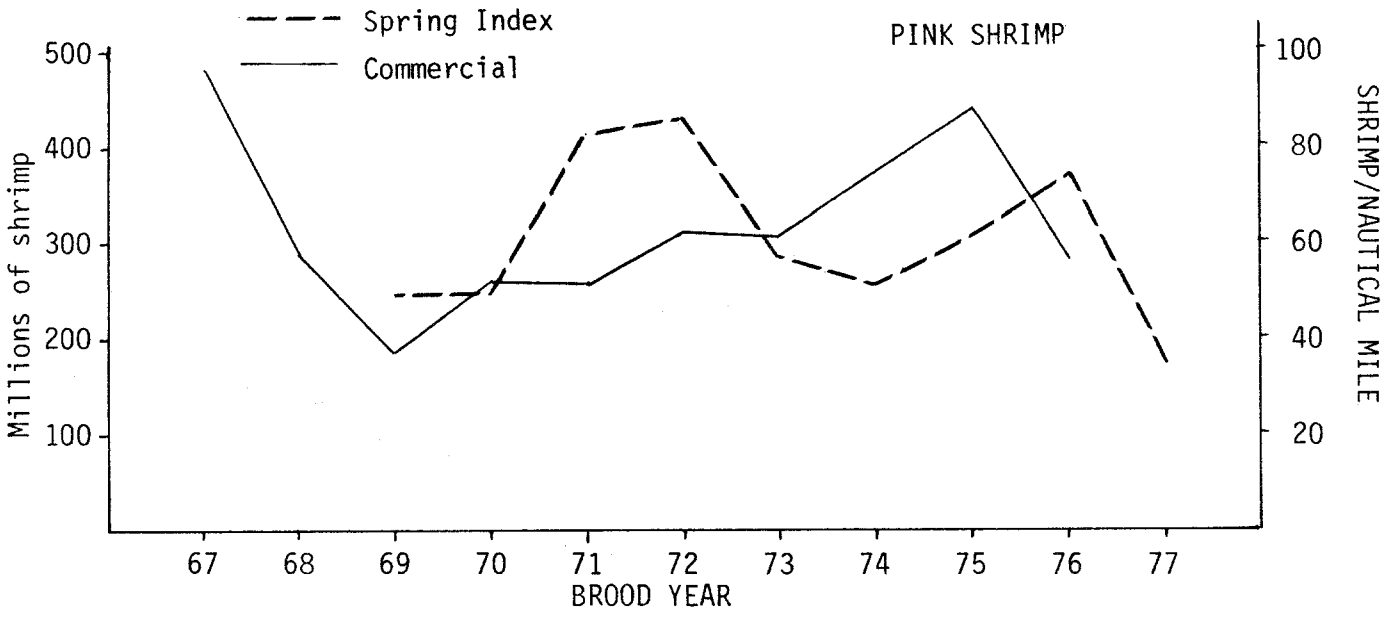
Table 13. Number of humpy shrimp by size class based on number per pound weighting of the commercial fishery and index trawl surveys of Lower Cook Inlet.

NUMBERS OF SHRIMP BY SIZE CLASS FROM COMMERCIAL SAMPLES

Brood Year	I	II	III	IV	V	Total
1965					3,160	
1966				73,254	2,410	
1967			84,152	63,898	5,578	153,628
1968		23,295	82,420	79,434	26,799	211,948
1969	186	27,074	100,600	109,559	61,907	299,326
1970	476	44,883	144,226	109,921	46,730	346,236
1971	107	23,941	70,983	75,899	19,994	190,924
1972	0	17,890	50,645	73,296	1,768	143,599
1973	0	9,374	54,021	31,589	4,475	99,459
1974	0	38,681	95,288	84,004	14,549	232,522
1975	126	58,707	201,766	114,361	9,427	384,387
1976	679	72,682	120,668	94,935		288,964
1977	0	44,778	171,219			
1978	488	38,294				
1979	736					

NUMBER OF SHRIMP BY NAUTICAL MILE FROM SPRING INDEX IN THOUSANDS

Brood Year	I	II	III	IV	V	Total
1967				0.2	0	
1968			1.3	2.1	0.1	
1969		.9	10.2	5.6	0.4	17.1
1970	0.2	2.4	13.1	2.0	10.8	28.5
1971	0.3	8.7	2.6	29.9	0.5	42.0
1972	0.1	0.3	12.2	1.1	0.1	13.8
1973	0	3.0	1.3	0.7	0.1	5.1
1974	0.1	0.7	0.6	5.0	0.1	6.5
1975	0	0.1	18.3	3.9	0.6	22.9
1976	0	8.6	9.3	5.1	0.2	23.2
1977	0.2	2.3	8.2	2.6		13.0
1978	0.1	0.7	5.2			
1979	0	2.9				
1980	0.3					



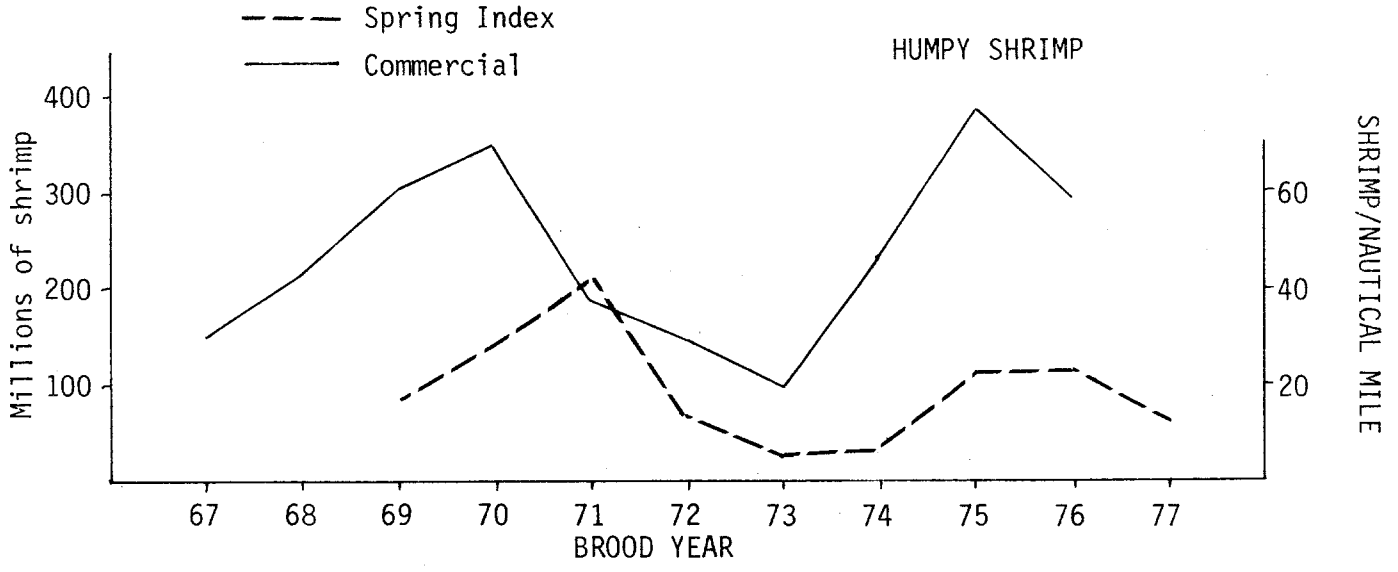


Figure 21. Number of shrimp by brood year for commercial harvests and spring index cruises.

$$\text{Weight} = (A)\ (\text{length}^{B}).$$

Both pink and humpy shrimp show a slight difference in the older age classes indicating a heavier shrimp for a given carapace length during the December to March period. These data suggest that shrimp harvested in the winter would result in more poundage for the same number of individuals as compared to a summer harvest. This is probably a result of egg development in the winter months.

RECOMMENDATIONS

1982-83 Trawl Shrimp Fishery

The May 1982 research trawl survey resulted in the lowest abundance index since the first year of the program (1971). A high incidental catch of fish occurred during the program. The major species was pollock. Due to the abundance index, the suggested shrimp harvest level for the 1982-83 season (begins 1 July 1982) is 3 million total, split equally between three seasons. This harvest is subject to adjustment based on the fall 1982 research trawl survey.

A major population shift that occurred during the 1981-82 season was the movement of humpy shrimp from the traditional areas west of the Homer spit, to the waters east (inside) of the Homer spit. Future surveys should show if this population shift is permanent.

Measuring devices for the research trawl nets should be installed to determine headrope length, headrope height, footrope height, and door width while the net is fishing. Temperature and salinity at depth information should be collected for each survey.

It is recommended that the trawl surveys be continued on the twice-yearly schedule.

Commercial Fishery Sampling

Catch sampling of the commercial fishery should be maintained at the same level as previous years. Emphasis should be placed on sampling vessels that trawl in different areas each fishing period.

Data Analysis

Further data analysis that should be completed is the development of computer programs to store and analyse log book information from commercial fishermen. Further analysis of age-carapace length data should be completed, especially for coonstripe and sidestripe shrimp stocks.

ACKNOWLEDGMENTS

Temporary employees Jill Renfrew, Jim Herbert, Paul Budge, Rance Morrison, and Doug Loshbaugh completed the analysis of shrimp samples for the index and commercial fishery catches.

The crew of the state vessel PANDALUS is commended for their assistance in the shrimp index cruises.

The commercial vessels in the fishery provided twice weekly samples of their catches for analysis and are thanked for their cooperation.

The National Marine Fisheries Service provided sampling data from commercial and research catches for the period 1970 through 1974.

Fred Jamsen is commended for his data analysis programs for shrimp samples and providing length frequency plots.

Sally Morris is thanked for her efforts in typing the paper.

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APPENDICES

Appendix A. Alaska Board of Fisheries Kachemak Bay trawl shrimp management plan.

The Alaska Board of Fisheries recognizes that shrimp stocks in the Kachemak Bay area of Cook Inlet are a discrete stock and should be managed as a separate entity from other Gulf of Alaska shrimp stocks.

Based on historic catch information and relative abundance index surveys, the Kachemak Bay shrimp stocks experience normal population fluctuations. These populations appear to be able to sustain the historic annual harvest of 5,000,000 pounds when the catch occurs in equal portions throughout the year from June through March.

The Kachemak Bay shrimp fishery is comprised of two major species, pink (P. borealis) and humpy (P. goniurus) shrimp. Humpy shrimp do not become available to the fishery in most years until fall which further necessitates a prolonged harvest period and split seasons.

The following management strategies should be used when regulating this fishery:

1. Weekly catch rates should remain consistent with historic levels. These rates should be set to provide that fishing will occur over several weeks during each season. It is anticipated that the number of weeks fished will be a minimum of nine (9) weeks during each of the three seasons and that the minimum weeks fished during a fishing year may total 27.

2. Seasons should be set to insure that the harvest is allocated throughout the year to utilize all segments of the stocks and species as they become available to the fishery.

3. Daily fishing periods will be set insofar as possible to balance day and nighttime hours of fishing if applicable to harvest different stocks or accommodate various fisheries.

4. Management by guideline harvest levels should be conservative until adequate data base is established to justify a substantial increase in the guideline harvest level.

5. Areas closed to trawl shrimp fishing should remain substantially the same with the possibility that further area closures may be enacted to protect juvenile rearing shrimp or congregating females during the egg hatch period.

STATEMENT OF POLICY ON SMALL SHRIMP

It is the intent of the Board of Fisheries that the harvest of any portion of a shrimp stock comprised predominantly of shrimp less than two years of age be discouraged.

- continued -

Appendix A. Alaska Board of Fisheries Kachemak Bay trawl shrimp management plan (continued).

The Board encourages the staff of the Department of Fish and Game to determine the distribution of these age groups in commercial fishing areas and to evaluate the incidence of these age groups in the commercial fishery. The Board recognizes that the harvest of a small proportion of these age groups is unavoidable; however, intense fishing pressure on segregated schools of small shrimp may jeopardize future brood stocks. The Board directs the staff of the Department to take whatever corrective action necessary when harvesting small shrimp is determined to be biologically unsound.

Appendix Table 1. Summary of weekly fishing periods for the trawl shrimp fishery in Lower Cook Inlet.

	1979-80 Season			1980-81 Season			1981-82 Season		
Wk	Start Date	Hours	Shrimp Catch 1000 lb	Boats	Start Date	Hours	Shrimp Catch 1000 lbs.	Boats	Start Date	Hours	Shrimp Catch 1000 lb	Boats
1	2 Jul 79	96	164	3	1 Jul 80	18	114	7	6 Jul 81	57	164	2
2	9 Jul	72	165	4	7 Jul	18	165	5	16 Jul	18	125	2
3	16 Jul	72	189	4	14 Jul	24	134	5	20 Jul	62	210	2
4	23 Jul	48	186	4	21 Jul	12.5	223	6	27 Jul	31	131	5
5	30 Jul	48	204	3	28 Jul	11.5	162	6	3 Aug	24	181	5
6	6 Aug	144	138	3	4 Aug	30	165	4	10 Aug	11	94	9
7	13 Aug	72	233	3	11 Aug	10	147	4	17 Aug	8.5	156	8
8	20 Aug	48	164	3	18 Aug	18	150	6	24 Aug	4.5	181	10
9	27 Aug	105	237	3	25 Aug	10	268	6	31 Aug	3	72	10
10	4 Sep	96	211	2	2 Sep	10	254	7	8 Sep	12	200	10
11	10 Sep	33	129	3								
Sub Total		(834)	(2,013)			(162)	(1,781)			(231)	(1,614)	
1	1 Oct 79	108	186	3	1 Oct 80	4.5	145	7	5 Oct 81	18	153	7
2	8 Oct	36	183	5	6 Oct	5	138	8	12 Oct	10.5	220	6
3	15 Oct	36	185	5	13 Oct	7.5	168	12	19 Oct	6.5	135	12
4	22 Oct	15	185	6	20 Oct	16	217	13	26 Oct	8	200	16
5	29 Oct	32	181	6	27 Oct	24	239	13	2 Nov	3.5	64	19
6	5 Nov	36	193	6	3 Nov	13	269	13	9 Nov	7	176	19
7	12 Nov	11	182	6	10 Nov	13	265	12	16 Nov	5	151	17
8	19 Nov	28	180	4	17 Nov	6.5	314	11	23 Nov	7	134	14
9	26 Nov	26	173	4	24 Nov	26	269	12	30 Nov	16	139	9
10	3 Dec	81	205	4	1 Dec	19	270	11	7 Dec	9.5	174	13
11	10 Dec	221	197	5	8 Dec	19	210	10	14 Dec	9	150	14
12					15 Dec	27	190	8				
Sub Total		(630)	(2,053)			(180.5)	(2,692)			(100)	(1,696)	

-Continued-

Appendix Table 1. Summary of weekly fishing periods for the trawl shrimp fishery in Lower Cook Inlet (continued).

	1979-80 Season				1980-81 Season				1981-82 Season			
Wk	Start Date	Hours	Shrimp Catch 1000 lb	Boats	Start Date	Hours	Shrimp Catch 1000 lbs.	Boats	Start Date	Hours	Shrimp Catch 1000 lb	Boats
1	2 Jan 80	52	257	6	5 Jan 81	19	208	11	4 Jan 82	16	175	13
2	7 Jan	48	227	6	12 Jan	10	178	13	11 Jan	13.5	192	14
3	14 Jan	109	205	6	19 Jan	20	208	13	18 Jan	16	205	14
4	21 Jan	99	233	5	26 Jan	10	205	14	25 Jan	11	185	13
5	28 Jan	29	222	8	2 Feb	10	179	14	1 Feb	11.5	186	15
6	4 Feb	62	134	4	9 Feb	6.5	157	14	8 Feb	10	178	16
7	11 Feb	15	156	4	16 Feb	8	190	16	15 Feb	114	28	1 1/
8	18 Feb	12.5	146	4	23 Feb	8	208	14	22 Feb	28.5	269	15
9	25 Feb	10	148	5	2 Mar	6.5	175	14	1 Mar	16		15
Sub Total		(436.5)	(1,731)			(98)	(1,707)			(122.5)		
TOTAL		1,900.5	5,797			440.5	6,180			453.5		

1/ Not Included in Totals

Appendix Table 2. Summary of weighted average CPUE in pounds per drag hour for the three primary vessels in the Southern District, west of the Homer spit.

YEAR	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1969							2,041	1,606	3,651	3,630		
1970				2,512	2,512	1,421	2,083	2,014	2,176	2,355	2,849	1,396
1971	3,499	3,704	9,559	2,197	1,623	1,314	818	2,190	3,244	2,965	2,746	2,949
1972	5,322	5,247	10,247	3,062	2,443	3,617	1,691	2,991	4,538	4,666	3,117	2,881
1973	2,722	4,292				2,660	2,995	3,716	5,066		4,238	5,922
1974	5,231	11,929	18,846			3,022	2,991	2,771	5,481	4,617	4,900	6,252
1975	5,415	5,231	8,043			3,436	3,735	2,852	3,451	3,179	2,042	3,123
1976	2,216	4,440	5,136			1,637	2,252	2,393	3,832	3,471	2,273	2,199
1977	2,937						2,305	3,254	3,939	4,393	4,312	3,101
1978	1,371	3,695				2,273	2,378	2,737			4,530	3,836
1979							3,155	4,497	7,745	4,916	6,898	8,258
1980	4,585	4,648					4,176	7,221	9,688	4,593	6,251	3,708
1981	3,557	4,551	9,073				3,886	9,653	4,914	5,716	3,676	3,469
1982		2,887	6,530									

Appendix Table 3. Summary of weighted average CPUE in pounds per drag hour for the three primary vessels in the Southern District, east of the Homer spit.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1969								700		2,152	1,812	2,298
1970	2,789	2,783	2,887	1,986						1,650	1,285	1,445
1971	1,105	3,050										
1975								1,000		2,409	2,981	2,340
1976	1,880										3,402	2,736
1977	2,291						2,008		2,649		4,171	3,162
1978	2,599	3,488				1,526	1,474				2,971	1,491
1979							2,358	2,445		2,273		5,634
1980	3,407	3,711					1,266			1,707	2,956	2,398
1981	2,904	5,287								2,913	4,046	3,932
1982	4,138	3,631	2,954									

Appendix Table 4. Summary of weighted average CPUE in pounds per drag hour for the three primary vessels in the Southern District of Cook Inlet.

Fishing Year Weighted Average	YEAR	TOTAL AREA Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	1969							2,041	1,426	3,651	2,785	1,812	2,298
2,562	1970	2,789	2,783	2,887	2,295	2,512	1,421	2,083	2,014	2,176	2,144	2,155	1,440
3,357	1971	2,418	3,609	9,559	2,197	1,623	1,314	818	2,190	3,244	2,965	2,746	2,949
3,181	1972	5,322	5,247	10,274	3,062	2,443	3,617	1,691	2,991	4,538	4,666	3,117	2,881
3,380	1973	2,722	4,292				2,660	2,995	3,716	5,066		4,238	5,922
5,231	1974	5,231	11,929	18,846			3,022	2,991	2,771	5,481	4,617	4,900	6,252
4,910	1975	5,415	5,231	8,043			3,436	3,735	2,849	3,451	3,013	2,802	2,464
3,262	1976	1,902	4,440	5,136			1,637	2,252	2,393	3,832	3,437	2,908	2,513
2,898	1977	2,730						2,044	3,254	3,712	4,393	4,291	3,137
3,404	1978	2,557	3,511				2,145	2,368	2,737			4,307	3,494
3,233	1979							3,108	4,294	7,745	4,852	6,898	7,422
4,948	1980	3,993	4,250					4,154	7,221	9,688	4,500	5,765	3,112
5,065	1981	3,309	4,698	9,073				3,886	9,653	4,914	4,581	3,487	3,399
4,954	1982	4,138	3,598	5,324									
Weighted Average CPUE		3,639	4,582	8,711	2,307	2,260	2,314	2,694	3,951	4,346	3,993	4,214	3,712

Appendix Table 5. Formulas used to expand by the Number/Lb Method (Jamsen 1981).

gmlb	=	Number of grams/lb = 453.59237
W	=	weight (lbs) of shrimp taken during a period
Nis	=	Number of species i in a sample
$\sum$Nis	=	Number of species i in samples taken during a period
Wis	=	Weight (gms) of species i in a sample
$\sum$Wis	=	Weight (gms) of species i in samples taken during a period
$\sum\sum$Wis	=	Weight (gms) of samples taken during a period
Wi	=	$W \frac{\sum Wis}{\sum\sum Wis}$ = weight (lbs) of species i taken during a period
Ni	=	$(Wi)(gmlb)\frac{\sum Nis}{\sum Wis}$ = Number of species i taken during a period
Nisl	=	Number of species i in length class l in samples taken during a period.
Nil	=	$Nisl \frac{Ni}{\sum Nis}$ = Number of species i in length class taken during a period

Appendix Table 6. Formulas used to expand by the Length-Weight Curve Method (Jamsen 1981)

gmlb	=	Number of grams/lb = 453.59237
W	=	Weight (lbs) of shrimp taken during a period
Nis	=	Number of species i in a sample
Wism	=	Calculated weight (gms) of species i measured in a sample using length-weight curves.
$\sum$ Wism	=	Calculated weight (gms) of species i measured during a period.
Nism	=	Number of species i measured in a sample
$\sum$ Nism	=	Number of species i measured in samples during a period
Wis	=	$\text{Wism} \frac{\text{Nis}}{\text{Nism}}$ = Calculated weight (gms) of species i in a sample
$\sum$ Wis	=	Sum of calculated weights (gms) of species i in sample taken during a period
$\sum\sum$ Wis	=	Sum of calculated weights (gms) of samples taken during a period
Wi	=	$W \frac{\sum \text{Wis}}{\sum\sum \text{Wis}}$ = Weight (lbs) of species i taken during a period
Ni	=	$\sum \text{Nism} \frac{(\text{gmlb})\ (\text{Wi})}{\sum \text{Wism}}$ = Number of species i taken during a period
Nisl	=	Number of species i in length class l in samples taken during a period
Nil	=	$\text{Nisl} \frac{\text{Ni}}{\sum \text{Nism}}$ = Number of species i in length class l taken during a period

Appendix Table 7. Total commercial trawl shrimp fishery catch composition for the Southern District of Lower Cook Inlet[1/].

	Month	Total Pounds	Pink P. borealis Pounds	%	Humpy P. goniuris Pounds	%	Coon P. hypsinotus Pounds	%	Side P. dispar Pounds	%
1970-71	6-8		1,574,204	69	622,192	27	72,378	3	15,673	1
	9		380,077	63	201,718	33	20,737	3	585	0
	10		254,089	78	10,919	3	16,956	5	42,396	13
	11		212,103	55	60,242	16	58,308	15	55,699	14
	12		106,218	66	1,305	1	20,898	13	33,347	21
	1		81,000	79	0	0	21,435	21	401	0
	2		311,038	70	66,098	15	35,577	8	33,423	7
	3-4		726,832	50	446,519	31	65,266	5	206,784	14
	5		77,758	51	71,501	47	687	0	1,625	1
Season Total		5,905,988	3,723,319	63	1,480,494	25	312,242	5	389,933	6
1971-72	6		303,809	71	109,239	25	15,240	4	1,779	0
	7		337,552	70	119,746	25	25,623	5	1,441	0
	8		468,411	79	113,792	19	7,256	1	1,443	0
	9		361,024	58	255,462	41	6,191	1	2,130	0
	10		221,101	45	264,394	54	2,787	1	210	0
	11		320,101	70	87,103	19	15,886	3	34,732	8
	12		117,801	73	20,589	13	10,152	6	11,988	7
	1		216,048	53	117,534	29	22,505	6	49,643	12
	2		375,648	59	111,203	17	106,493	17	45,753	7
	3		38,423	39	51,498	52	5,384	5	3,585	4
	4		49,285	64	24,632	32	183	0	3,033	4
	5		37,963	60	25,465	40	17	0	129	0
Season Total		4,520,906	2,846,666	63	1,300,657	29	217,717	5	155,866	3
1972-73	6		308,122	58	197,275	37	22,547	4	7,862	1
	7		404,750	74	123,051	23	2,728	1	13,925	3
	8		272,483	48	288,501	51	7,449	1	261	0
	9		138,992	29	328,762	70	4,167	1	0	0
	10		489,711	75	158,280	24	3,394	1	162	0
	11		369,812	60	113,354	18	69,037	11	66,578	11
	12		187,873	39	280,211	58	5,611	1	6,645	1
	1		293,106	65	95,226	21	59,633	13	2,908	1
	2		187,017	43	115,207	27	20,618	5	108,234	25
Season Total		4,753,492	2,651,866	56	1,699,867	36	195,184	4	206,575	4

-continued-

Appendix Table 7. Total commercial trawl shrimp fishery catch composition for the Southern District of Lower Cook Inlet 1/ (continued).

	Month	Total Pounds	Pink P. borealis Pounds	%	Humpy P. goniuris Pounds	%	Coon P. hypsinotus Pounds	%	Side P. dispar Pounds	%
1973-74	6		440,044	74	116,161	20	31,798	5	6,773	1
	7		507,470	47	548,789	51	22,172	2	7,913	1
	8		321,800	44	384,431	53	15,549	2	5,815	1
	9		2,076	3	70,048	96	1,013	1	0	0
	11		257,327	60	169,799	39	1,235	0	2,662	1
	12		147,049	26	408,495	72	12,041	2	2,664	0
	1		211,631	25	589,902	68	42,564	5	19,401	2
	2		52,220	33	103,104	66	588	0	612	0
	3		10,335	3	287,351	95	4,119	1	681	0
Season Total		4,805,632	1,949,952	41	2,678,080	56	131,079	3	46,521	1
1974-75	6-7		584,307	56	452,643	43	13,549	1	0	0
	8		229,939	48	226,138	47	19,394	4	3,482	1
	9		207,444	26	550,870	70	27,228	3	4,631	1
	10		20,920	11	168,896	87	3,323	2	0	0
	11		319,320	74	112,507	26	0	0	0	0
	12		175,786	41	216,682	51	10,488	2	21,945	5
	1		162,858	28	415,705	71	3,256	1	898	0
	2		292,129	51	243,958	43	18,452	3	18,599	3
	3		137,074	27	329,640	65	23,491	5	16,360	3
Season Total		5,031,912	2,129,777	42	2,717,039	54	119,181	2	65,915	1
1975-76	6-7		118,403	52	83,094	37	20,985	9	3,350	1
	8-9		377,601	28	951,063	70	23,358	2	1,966	0
	10-12		578,938	45	559,574	44	47,108	4	98,089	8
	1		352,050	69	116,032	23	10,038	2	31,775	6
	2-3		540,462	52	237,778	23	43,583	4	223,762	21
Season Total		4,419,009	1,967,454	45	1,947,541	44	145,072	3	358,942	8

-continued-

Appendix Table 7. Total commercial trawl shrimp fishery catch composition for the Southern District of Lower Cook Inlet 1/ (continued).

	Month	Total Pounds	Pink P. borealis Pounds	%	Humpy P. goniuris Pounds	%	Coon P. hypsinotus Pounds	%	Side P. dispar Pounds	%
1976-77	6		36,475	95	1,454	4	240	1	222	1
	7		231,243	72	64,323	20	7,764	2	17,792	6
	8		432,249	59	191,698	26	37,483	5	69,311	9
	9		335,067	47	339,459	47	19,087	3	23,192	3
	10		137,921	19	582,546	79	14,110	2	4,249	1
	11		624,453	75	83,802	10	15,828	2	107,496	13
	12		546,602	65	152,986	18	73,038	9	63,629	8
	1		543,139	69	128,351	16	61,367	8	52,410	7
Season Total		4,998,986	2,887,149	58	1,544,619	31	228,917	5	338,301	7
1977-78	6-7		291,755	81	15,456	4	16,149	4	36,554	10
	8		532,717	64	239,679	29	25,562	3	38,162	5
	9		382,260	52	257,346	35	14,093	2	86,821	12
	10		341,763	62	186,779	34	8,140	1	17,733	3
	11		502,615	63	207,449	26	49,995	6	33,031	4
	12		416,343	71	86,993	15	12,627	2	66,855	11
	1		636,664	76	89,208	11	42,395	5	72,453	9
	2		168,351	51	95,706	29	24,095	7	42,197	13
Season Total		5,037,946	3,272,468	65	1,178,616	23	193,056	4	393,806	8
1978-79	6		614,302	58	381,032	36	34,775	3	32,260	3
	7		876,089	51	730,408	42	58,386	3	59,617	4
	8		99,186	60	51,584	31	6,303	4	8,791	5
	11		982,288	41	1,289,949	55	32,042	3	72,271	3
	12		296,003	43	285,130	42	19,636	3	82,747	12
Season Total		6,012,799	2,867,868	48	2,738,103	45	151,142	3	255,686	4
1979-80	7		643,949	72	214,537	24	21,026	2	20,882	2
	8		479,853	62	284,928	37	3,681	0	4,127	1
	9		104,331	31	235,983	69	0	0	0	0
	10		270,249	29	613,644	67	6,374	1	29,145	3
	11		290,256	40	404,142	55	13,610	2	21,973	3
	12		204,608	51	172,244	43	10,607	3	15,794	4
	1		607,026	53	410,309	36	65,230	6	64,439	6
	2		295,239	51	161,636	28	22,998	4	104,606	18
Season Total		5,797,426	2,895,511	50	2,497,423	43	143,526	2	260,966	5

-continued-

Appendix Table 7. Total commercial trawl shrimp fishery catch composition for the Southern District of Lower Cook Inlet 1/ (continued).

	Month	Total Pounds	Pink P. borealis Pounds	%	Humpy P. goniuris Pounds	%	Coon P. hypsinotus Pounds	%	Side P. dispar Pounds	%
1980-81	7		285,216	36	463,109	58	13,411	2	34,852	4
	8-9		253,709	26	716,108	73	8,079	1	6,166	1
	10		380,358	42	482,603	53	20,825	2	22,664	3
	11		420,671	38	628,531	56	20,152	2	45,943	4
	12		529,792	79	11,496	2	31,764	5	96,947	14
	1		553,080	69	174,026	22	26,606	3	45,317	6
	2-5		534,312	59	224,997	25	20,723	2	127,922	14
Season Totals		6,179,379	2,957,138	48	2,700,870	44	141,560	2	379,811	6
1981-82	7		399,081	64	183,599	29	12,678	2	32,188	5
	8		361,253	46	379,051	48	14,261	2	32,414	4
	9		78,963	40	94,871	47	3,927	2	22,582	11
	10		330,611	47	284,857	41	12,841	2	70,652	10
	11		389,277	59	233,120	35	15,438	2	26,269	4
	12		201,413	62	60,450	19	7,003	2	54,850	17
	1		526,352	69	182,748	24	20,303	3	28,208	4
	2		349,890	53	264,350	40	25,814	4	21,490	3
	3		125,261	46	107,955	39	8,516	3	32,963	12
Season Totals		4,995,499	2,762,101	55	1,791,001	36	120,781	3	321,616	6

1/ Source - statistical runs, all years except 1978-79 and 1981-82. 1978-79 and 1981-82 are from Lower Cook Inlet Data Reports.

Appendix Table 8. Average weight per 0.5 mm carapace length for pink shrimp *(Pandalus borealis)* taken in Southern District, March 1979 - February 1980.

Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
7						.15				
8	0.4								.17	
8.5	0.5								.32	
9	0.43								.30	
9.5	0.48	0.47								
10	0.55	0.56	0.62							
10.5	0.76	0.66	0.73							
11	1.00	0.72	0.78							
11.5	.65	0.72	0.78						.60	
12	1.02		0.95		1.10	1.07	1.04		.93	
12.5	1.13	0.90	1.04		1.23	1.17	1.15	.90	1.03	
13	1.36	1.50			1.38	1.46	1.31	.90	1.22	1.31
13.5	1.48	1.45			1.55	1.43	1.44	1.28	1.38	1.54
14	1.66	1.62	1.37		1.66	1.61	1.60	1.52	1.55	1.52
14.5	1.81	1.76	1.73		1.78	1.66	1.72	1.68	1.73	1.71
15	2.01	1.92	1.93		2.01	1.80	2.47	1.80	1.93	1.77
15.5	2.17	2.02	2.06		2.29	2.11	2.11	1.95	2.16	1.90
16	2.37	2.15	2.24	2.45	2.54	2.43	2.35	2.20	1.64	2.24
16.5	2.61	2.49	2.45	2.56	2.81	2.53	2.45	2.43	2.47	2.45
17	2.83	2.72	2.64	2.87	2.94	2.77	2.80	2.43	2.83	2.70
17.5	3.10	2.91	2.88	3.13	3.28	3.01	2.92	2.78	3.08	2.90
18	3.28	3.17	3.02	3.30	3.52	3.20	3.15	3.26	3.35	3.18
18.5	3.95	3.35	3.28	3.73	3.77	3.40	3.58	3.48	3.53	3.32
19	4.40	3.58	3.69	4.01	4.00	3.73	4.12	4.00	4.42	3.77
19.5	4.74	3.92	3.94	4.26	4.41	4.04	4.45	4.05	4.57	3.98
20	5.12	4.22	4.21	4.53	4.68	4.37	4.82	4.91	4.94	4.76
20.5	5.52	4.58	4.65	4.98	5.01	4.52	5.40	4.69	5.41	5.20
21	5.83	4.91	4.75	5.56	5.43	4.83	5.65	5.25	5.88	5.56
21.5	6.33		5.38	5.53	5.79	5.22	5.92	5.80	6.35	5.50
22	7.10	5.63	5.77	5.87	6.20	5.71	6.63	5.99	6.76	6.33
22.5	7.97	5.73	6.12	6.27	6.44		7.04	6.55	6.95	7.12
23	8.20	7.00	6.66	6.36	6.91		7.59	6.63	7.24	7.24
23.5	7.25	6.50	6.85		7.27			6.00	7.69	7.80
24	7.85		7.45		7.75				7.45	7.45
24.5			6.60						8.2	
25										
25.5			7.60							
26			9.60							

Appendix Table 9. Average weight per 0.5 mm carapace length for humpy shrimp *(Pandalus goniurus)* taken in Southern District, March 1979 - February 1980.

Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
6.5						.14				
7.0						.1				
8.0	0.33									
8.5	0.38									
9.0	0.39									
9.5	0.45	0.50								
10.0	0.54	0.66								
10.5	0.62	0.79								
11.0	0.74	0.83								
11.5	0.89	0.94				.96				
12.0	1.17	1.11				1.15				
12.5	1.20	1.20				1.27				
13.0	1.41	1.39				1.42			1.38	1.38
13.5	1.58	1.52				1.54		1.50	1.50	1.44
14.0	1.71	1.62			1.78	1.67		1.50	1.58	1.70
14.5	1.96	1.77	1.90			1.81		1.73	1.58	1.85
15.0	2.24	1.92	1.70		2.18	2.02		2.10	1.88	1.96
15.5	2.39	2.08		2.40	2.30	2.33		2.00	2.26	2.23
16.0	2.78	2.32	2.49	2.62	2.56	2.44		2.37	2.45	2.30
16.5	2.79	2.51	2.70	2.74	2.79	2.66		2.45	1.85	2.52
17.0	3.05	2.74	2.92	3.08	2.99	2.87		2.81	2.73	2.82
17.5	3.63	3.35	3.21	2.97	3.14	3.01		3.16	3.09	3.56
18.0	4.11	3.67	3.54	3.54	3.59	3.24		3.61	2.95	3.53
18.5	4.72	4.01	3.64	3.80	3.75	3.60		3.81		4.09
19.0	5.04	4.44	4.29	4.14	4.14	3.71		4.19	4.3	4.41
19.5	5.36	4.70	4.37	4.37	4.42			4.27	4.7	4.57
20.0	5.77	5.03	4.74	4.61	4.77			4.72	5.07	5.18
20.5	6.15	5.11	4.90	5.00	5.02			5.03	5.26	5.94
21.0	6.47	5.74	5.31	5.33	5.36			5.45	5.82	6.07
21.5	6.48	5.85	5.56	5.55	5.56			5.98	6.1	6.09
22.0	7.56	6.00	5.66	5.91	6.02			6.39	5.64	5.18
22.5	7.40	6.00	6.13					6.40	6.45	6.99
23.0	7.90							6.40	7.05	
23.5								7.20		

Appendix Table 10. Average weight per 0.5 mm carapace length for coonstripe shrimp *(Pandalus hypsinotus)* taken in Southern District, March 1979 - February 1980.

Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
11										
11.5	1.10									
12										
12.5	1.70								1.5	
13	1.70	1.50							1.67	
13.5	1.80									
14		1.88							1.9	
14.5	2.38	1.95							1.8	
15	3.45								2.0	
15.5	2.70								2.4	
16		2.60							2.4	
16.5		2.25					3.1			
17	3.83									
18							3.91			
18.5					4.63		4.24			
19		4.80			4.92		4.57			4.3
19.5	6.28	5.04					4.92		5.2	
20	6.00	5.10			5.73	5.0	5.26		5.2	5.2
20.5	6.30	5.82			6.03				5.9	5.76
21	6.93	7.17			6.5	6.1	7.55	5.1	6.05	
21.5	7.37	6.42			7.00	6.25			7.3	6.4
22	7.68	6.74				7.25	7.05	6.85	6.8	6.6
22.5	8.00	7.07	7.55		8.17		7.30	6.6		7.4
23	8.80	7.54	8.53	8.4	8.45		7.99	7.7	7.77	7.8
23.5	10.10	7.58		8.8	9.27		8.37	8.7	8.9	8.35
24	9.33	9.19	9.00	9.54	10.05	9.8	8.25	8.8	9.3	
24.5	10.12	8.99	9.83	9.83	10.66	9.0	9.26		10.07	9.0
25	11.50	9.40	10.07	10.57	11.22	9.69	10.85	9.7	9.97	10.85
25.5		10.34	10.40	11.05	11.27	10.75	10.67	10.9	10.03	11.23

-continued-

Appendix Table 10. Average weight per 0.5 mm carapace length for coonstripe shrimp *(Pandalus hypsinotus)* taken in Southern District, March 1979 - February 1980 (continued).

Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
26	12.78	10.26	11.58	11.71	12.76	10.77	11.68	11.65	11.1	11.88
26.5	14.20	11.56	11.50	12.33	12.83	11.5	11.89	12.5	12.5	12.14
27		12.29	12.70	13.05	12.83	12.0	13.56	12.65	12.7	14.1
27.5	16.40	12.66	13.10	14.06	13.92		14.11			
28	18.40	12.50	14.55	15.02	15.27	14.0	15.15	14.0	13.64	
28.5		14.45	15.28	15.05	15.84	13.0	15.82	14.33		13.7
29	20.05	14.43	15.74	15.83	16.46		17.04	16.45	17.28	11.84
29.5	19.7	15.64	15.56	16.18	17.15	16.66	16.61		15.30	15.1
30	20.43	16.83	16.94	17.29	18.42	18.2	19.84		18.57	17.73
30.5	24.30	16.48	17.04	18.17	19.5	18.5	20.13		20.2	
31		16.16	19.36	18.89	19.58	19.42	19.88	20.6	19.73	
31.5	26.18	18.28	20.48	19.19	21.01		21.00	20.8		
32		18.93	19.13	20.42	22.38		21.38		22.08	25.57
32.5		18.50	20.70	21.08	23.04			22.3	22.3	24.75
33		19.15	22.04	21.45	23.56			24.3	23.4	26.07
33.5			20.70		25.14					
34				22.10						29.85
34.5			26.10							
35			27.30							
35.5			26.75							
36										

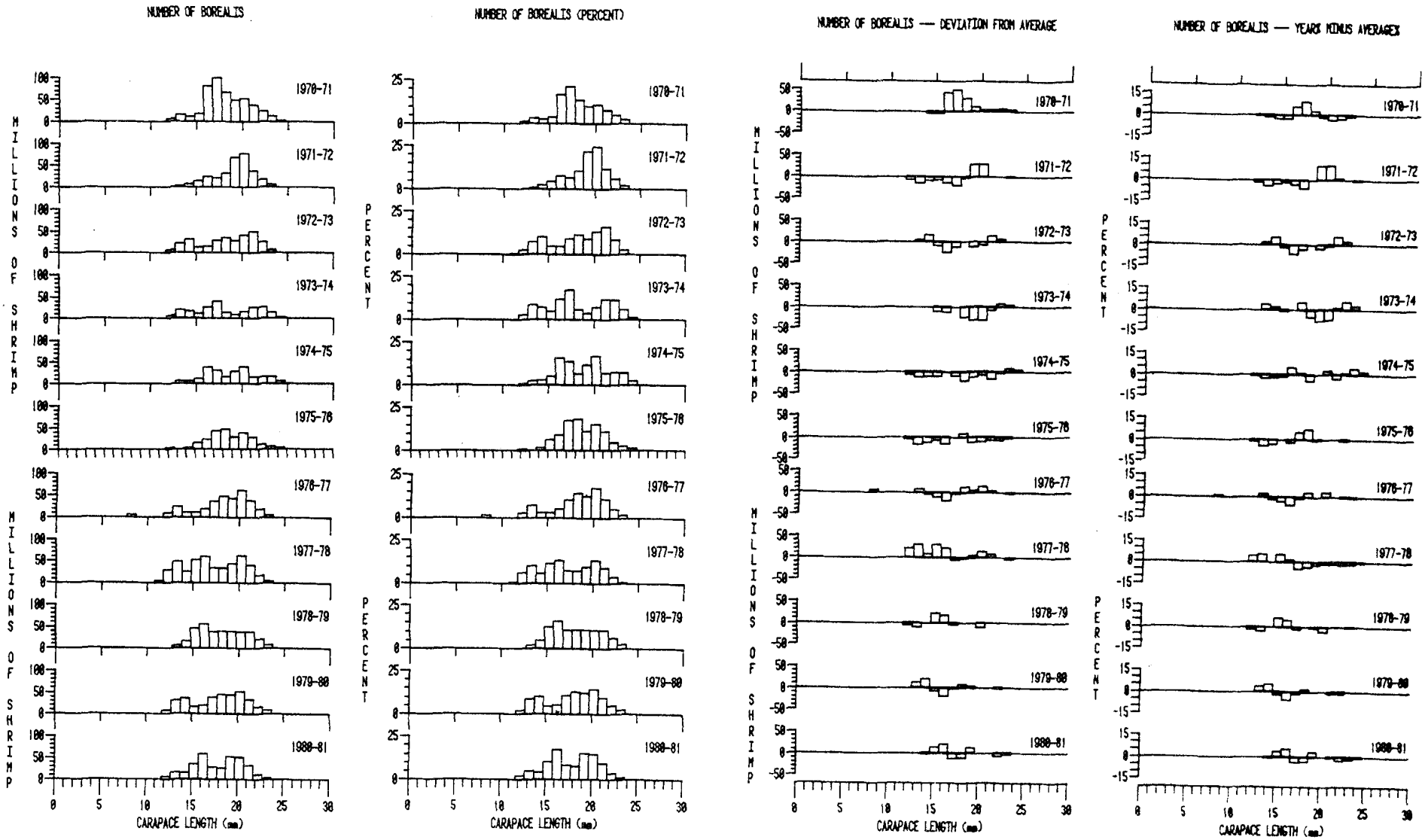
Appendix Table 11. Average weight per 0.5 mm carapace length for sidestripe shrimp *(Pandalopsis dispar)* taken in Southern District, March 1979 - February 1980.

Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
10										
10.5										
11										
11.5			0.76							
12			0.81							
12.5			0.93							
13			1.07							
13.5			1.07							
14			1.33							
14.5			1.38							
15			1.52		2.03					
15.5					2.05					
16					2.26	2.0	2.27			
16.5					2.53	2.25	2.32			
17	2.2		2.70		2.65		2.58			2.65
17.5					2.80	2.8	2.80			2.73
18	3.3	3.50				3.0	3.04	2.75		3.15
18.5						3.0	3.24	3.50		3.41
19	3.1	4.20					3.53	3.64		3.65
19.5	3.53	4.20	4.20				3.84	3.77		3.9
20	4.25	4.60	4.83				4.00	4.13		4.24
20.5	4.35	4.82	4.53					4.00		4.64
21	4.08	5.11	5.32							4.85
21.5	5.54	5.50	5.03							5.43
22	6.09	6.26	5.30		6.12		5.94			5.95
22.5	6.31	6.55	5.83		6.54	6.0	6.11	6.45		6.45
23	6.89	6.97	6.38		6.83		6.64	5.90		6.69
23.5	7.33	7.44	6.99				6.76	7.00		7.06
24	7.38	7.29	7.34		7.82		7.46			7.48
24.5	8.09	8.11	7.84		8.18		7.82	7.00		7.58

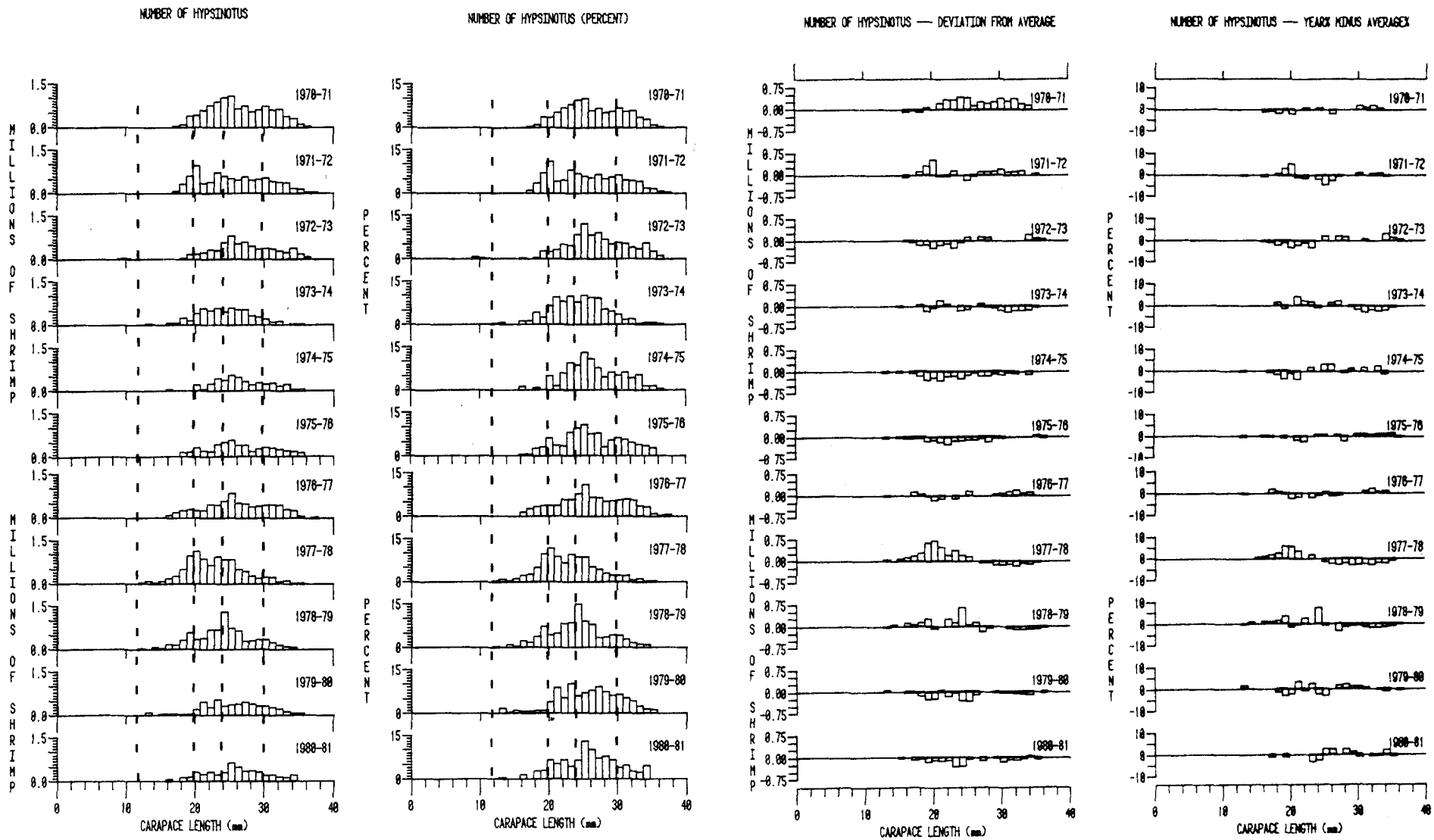
-continued-

Appendix Table 11. Average weight per 0.5 mm carapace length for sidestripe shrimp *(Pandalopsis dispar)* taken in Southern District, March 1979 - February 1980 (continued).

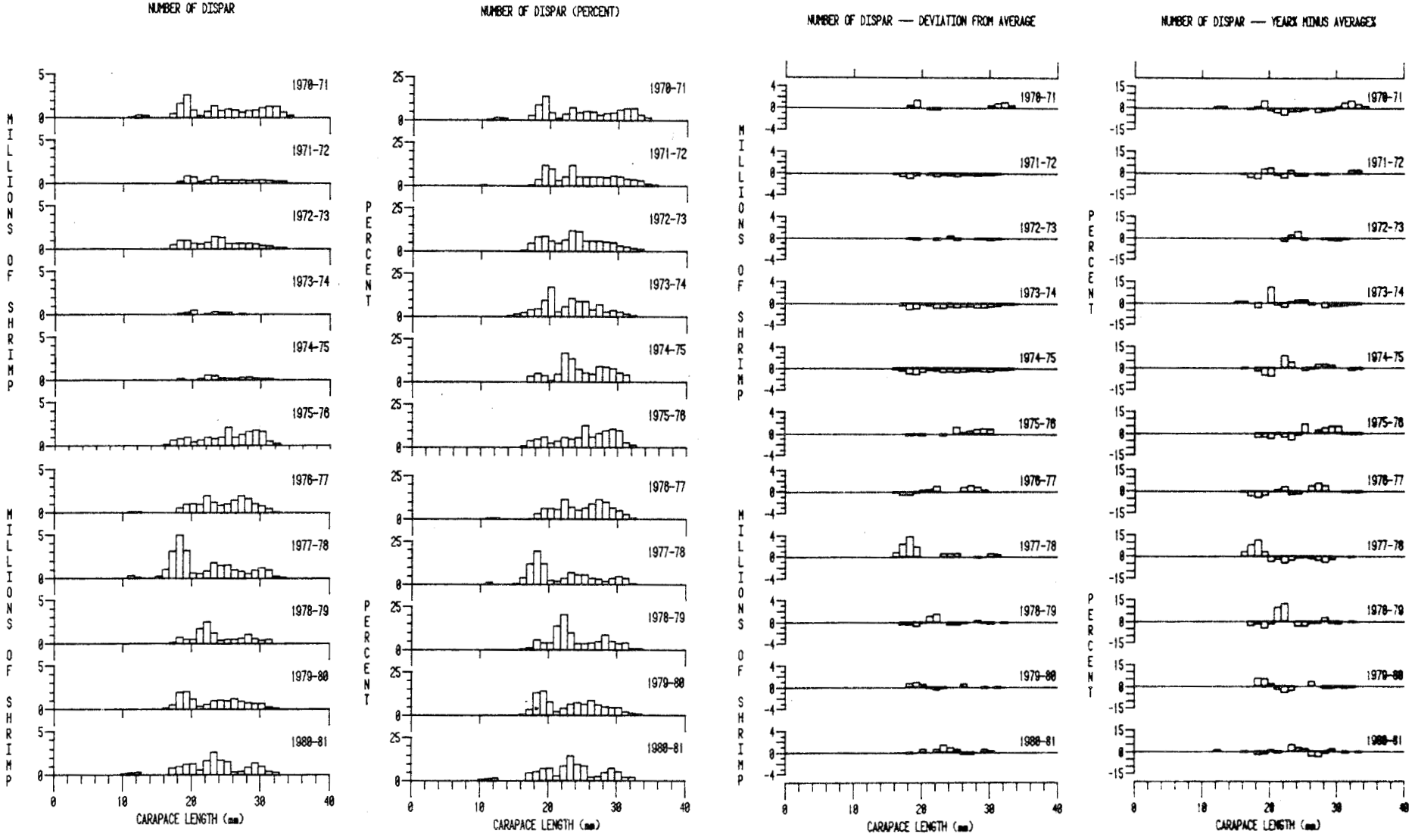
Carapace Length	Average Weight in Grams									
	Mar	May	June	July	Aug	Sept	Oct	Dec	Jan	Feb
25	8.53	8.15	8.05		8.63	8.75	8.61	8.10		8.78
25.5		8.90	8.40		9.40		8.95	8.65		8.76
26	11.41	9.57	9.06		9.72	10.25	10.09	9.50		8.72
26.5	9.43	10.00	9.05		9.82	10.75	10.12			10.33
27	12.72	11.25	9.92		10.40	11.33	10.99			11.84
27.5	11.62	10.50	11.19		11.88	11.33		11.10		12.84
28	13.52	12.12	11.90		12.79	12.62	12.41	12.70		12.93
28.5	15.25	14.7	13.20		12.80		13.13	13.60		14.93
29	15.21	14.1	13.68		13.80	13.5	13.80			15.34
29.5	15.35	14.2	13.90		13.83			14.10		16.65
30	17.25	15.68	13.70		14.70	15.0	15.20			17.18
30.5	17.70	15.00	14.60		16.35			16.80		18.61
31			16.47		19.15			15.80		18.61
31.5	19.94		16.50		16.40			17.55		20.52
32	21.3	19.00	17.60		17.60					20.15
32.5	21.5	22.00	18.70		18.90			19.00		21.7
33			17.45							22.9
33.5										23.1
34	22.7		17.60							
34.5										
35										
35.5										
36										
36.5										



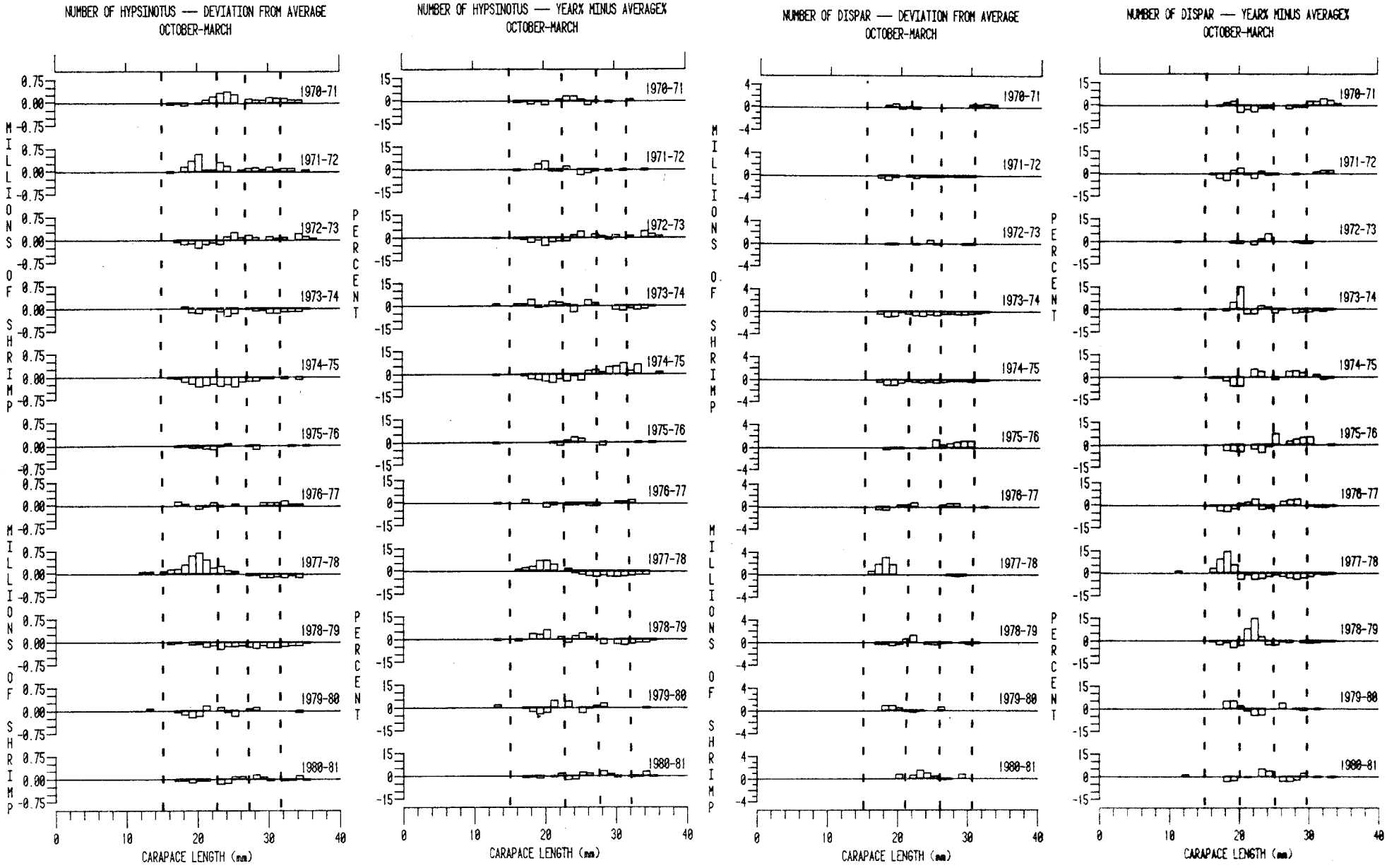
Appendix Figure 1. Carapace length frequency for pink shrimp *P. borealis* sampled from commercial catch deliveries.



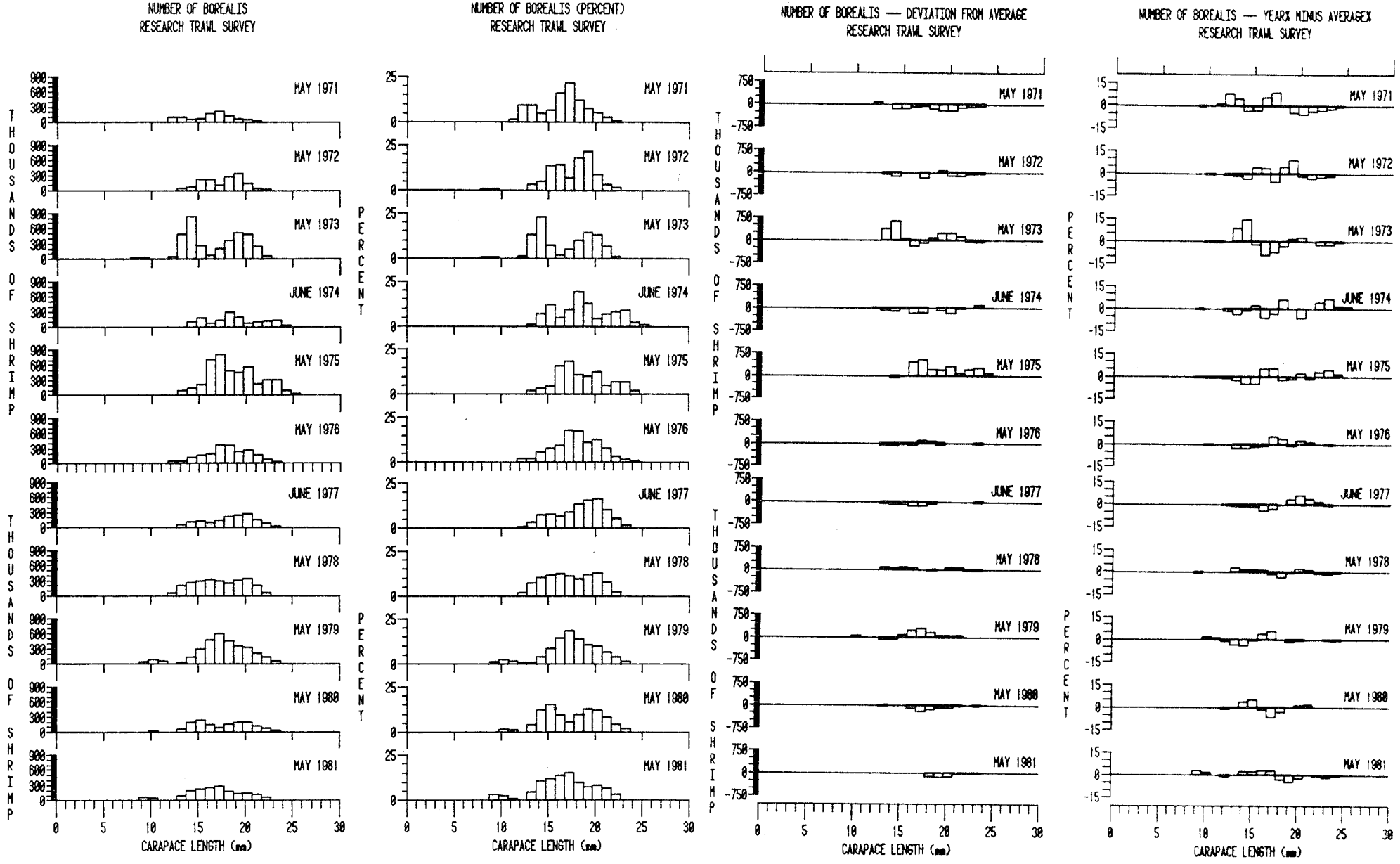
Appendix Figure 2. Carapace length frequency for coonstripe shrimp *P. hypsinotus* sampled from commercial catch deliveries (total year).



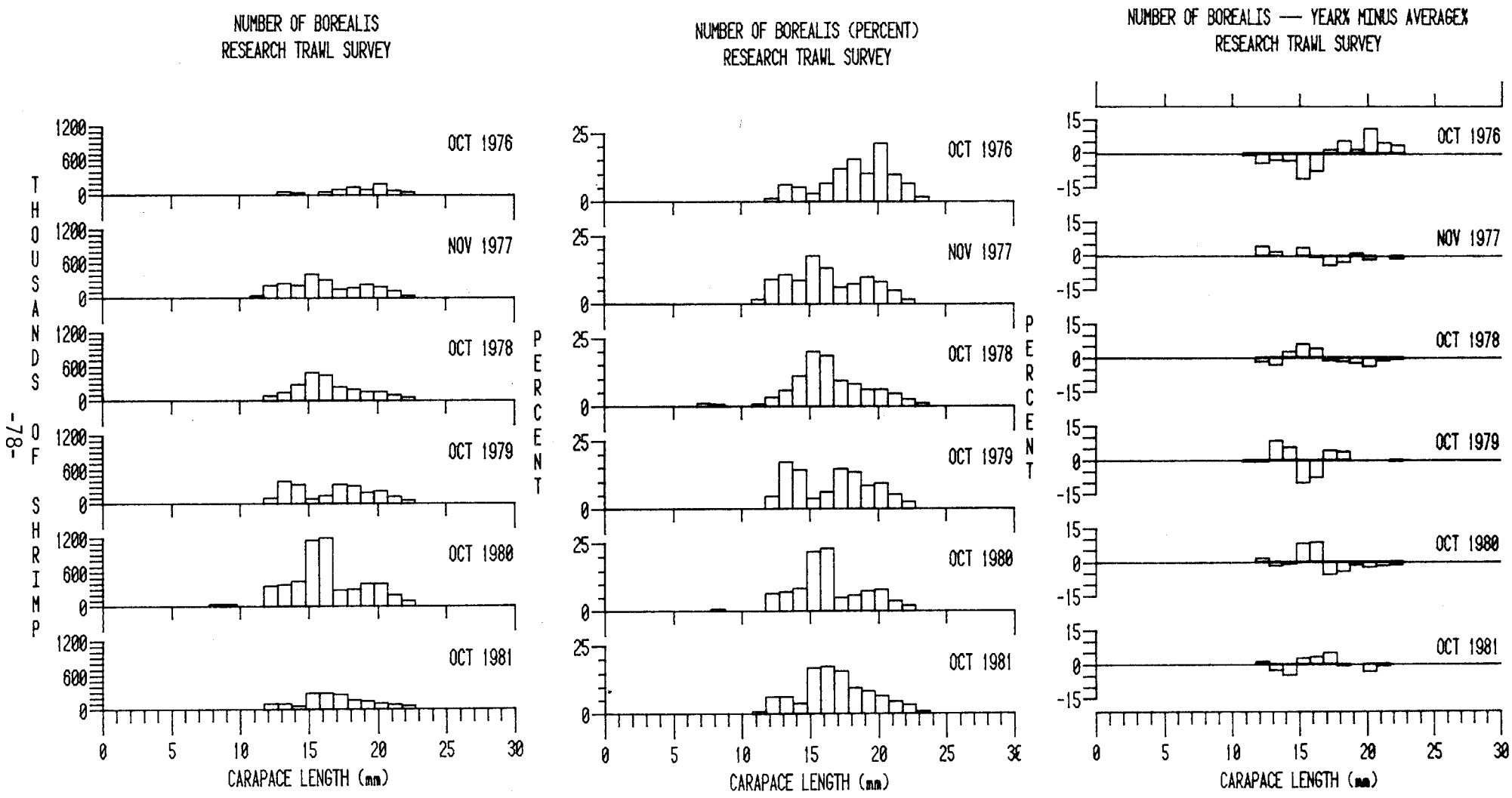
Appendix Figure 3. Carapace length frequency for sidestripe shrimp *P. dispar* sampled from commercial catch deliveries.



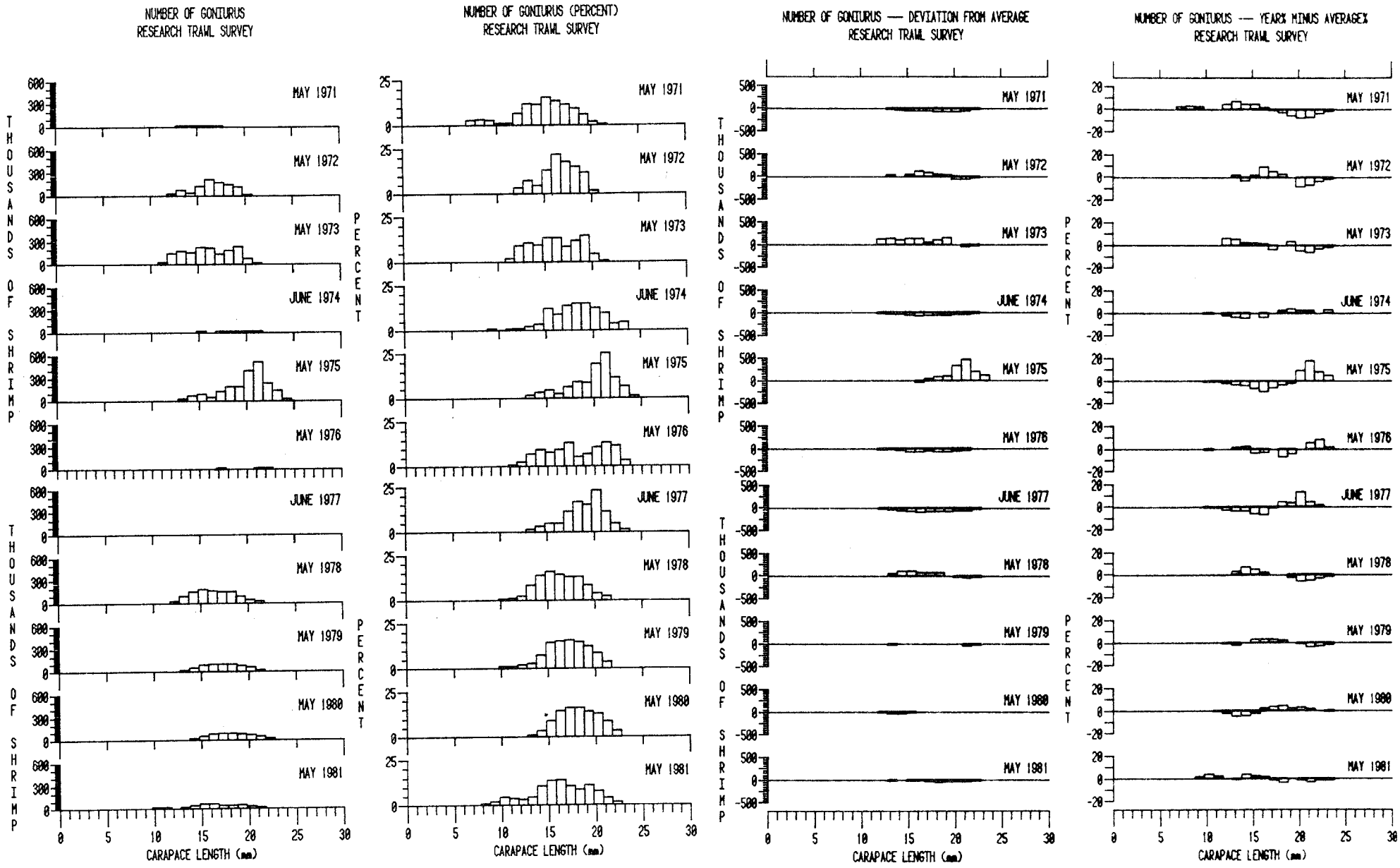
Appendix Figure 4. Carapace length frequency for coonstripe shrimp *P. hypsinotus* sampled from commercial catch deliveries.



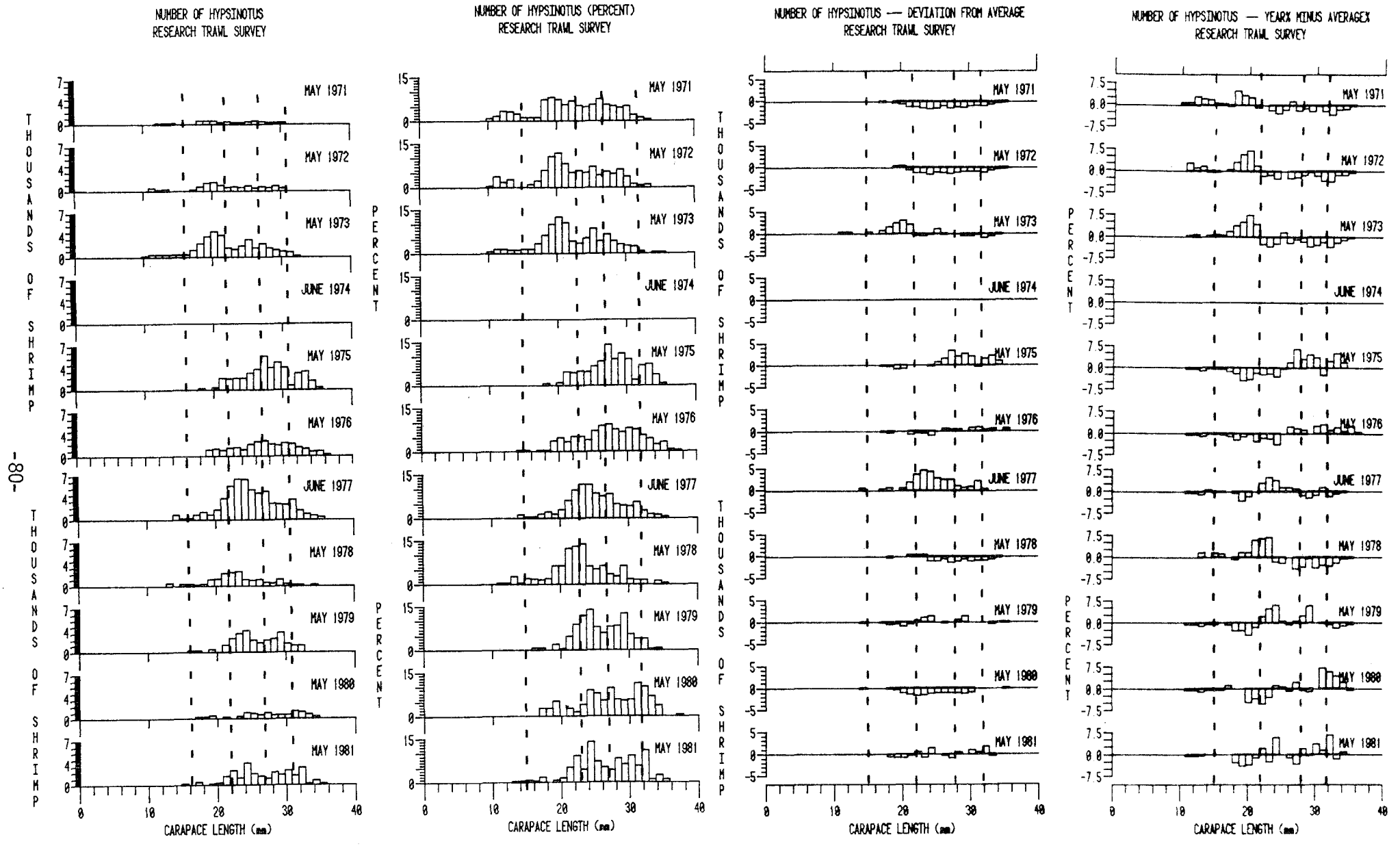
Appendix Figure 5. Carapace length frequency for pink shrimp *P. borealis* sampled from research trawl surveys.



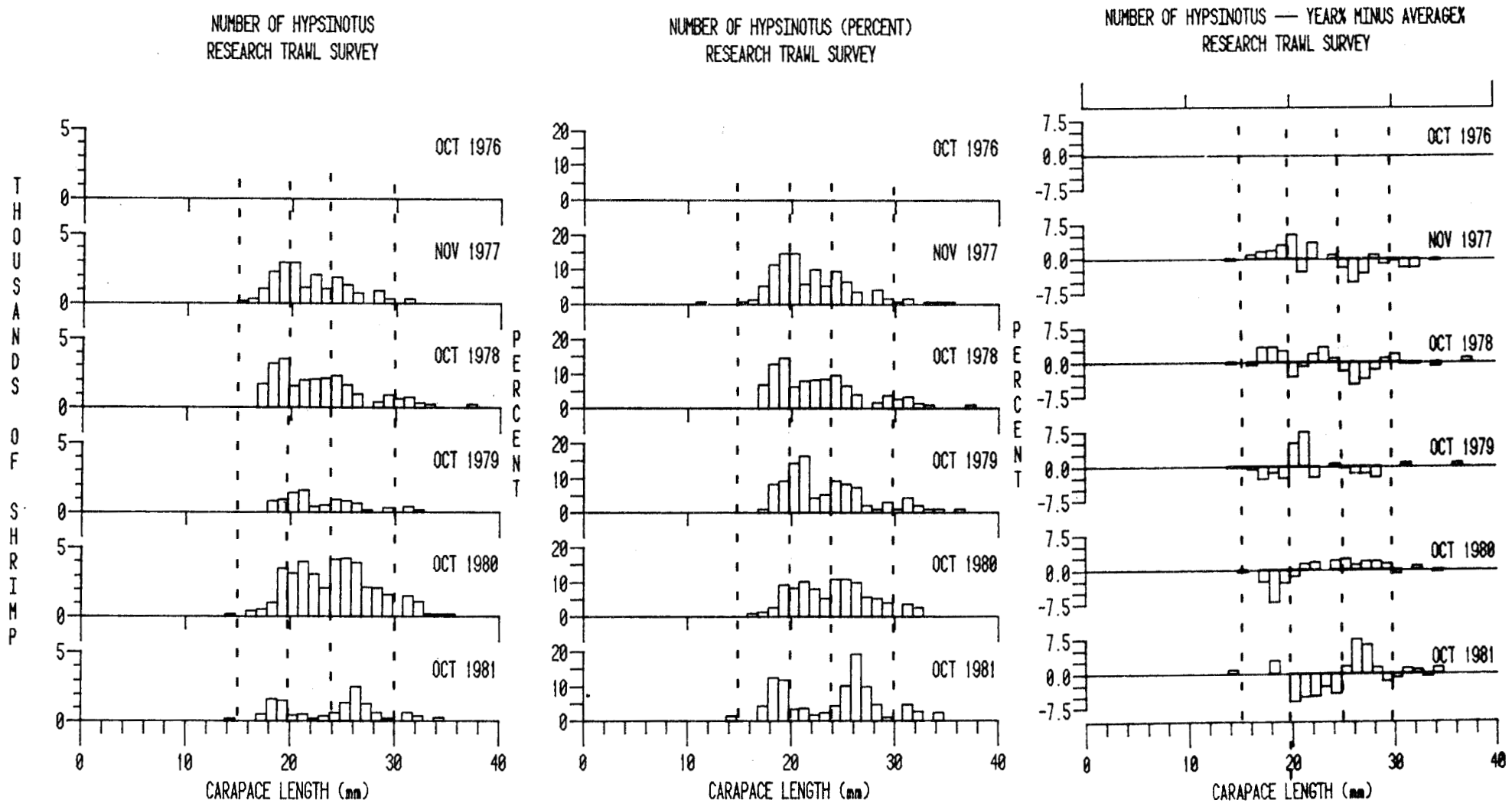
Appendix Figure 6. Carapace length frequency for pink shrimp *P. borealis* sampled from research trawl surveys.



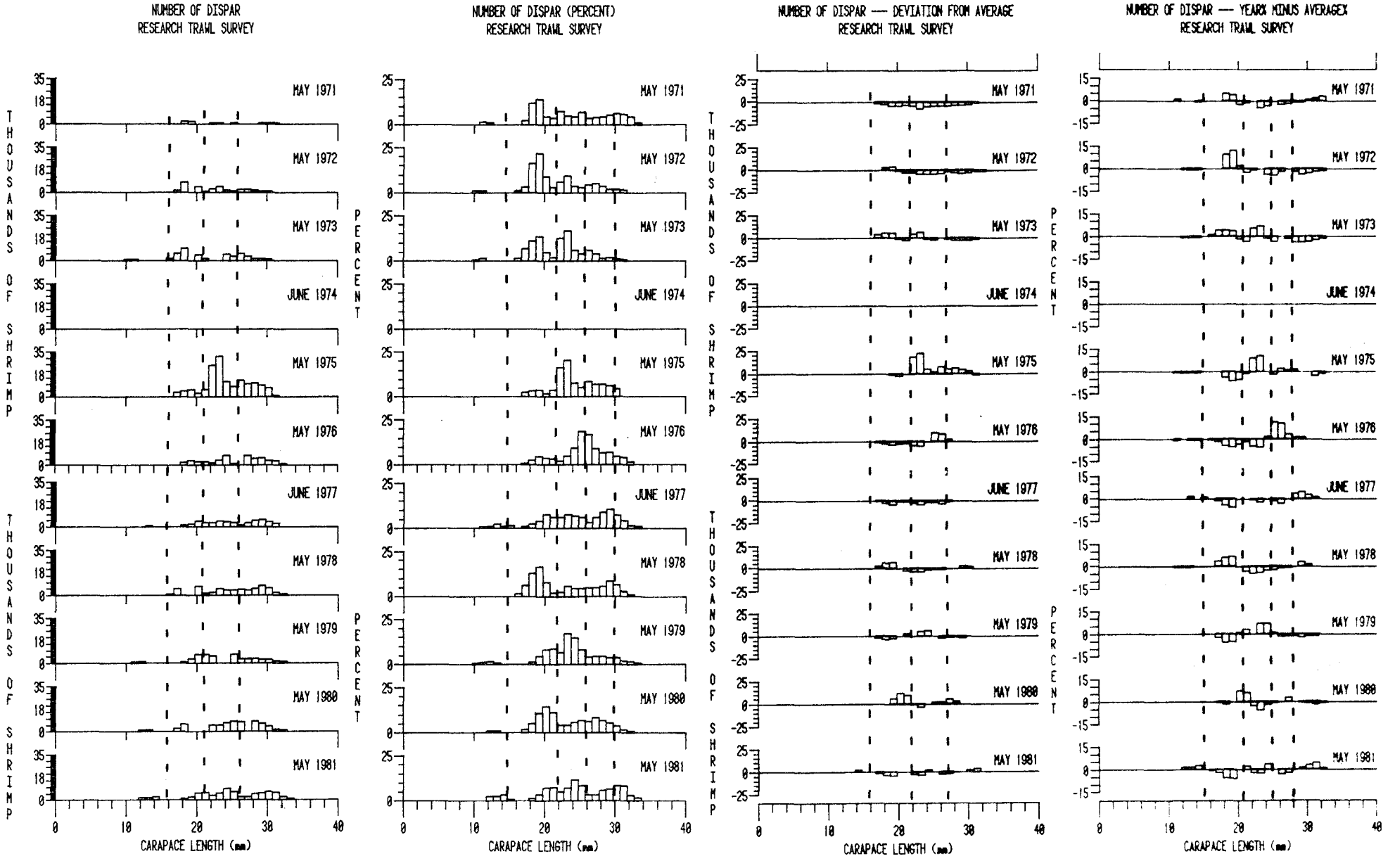
Appendix Figure 7. Carapace length frequency for humpy shrimp *P. goniurus* sampled from research trawl surveys.



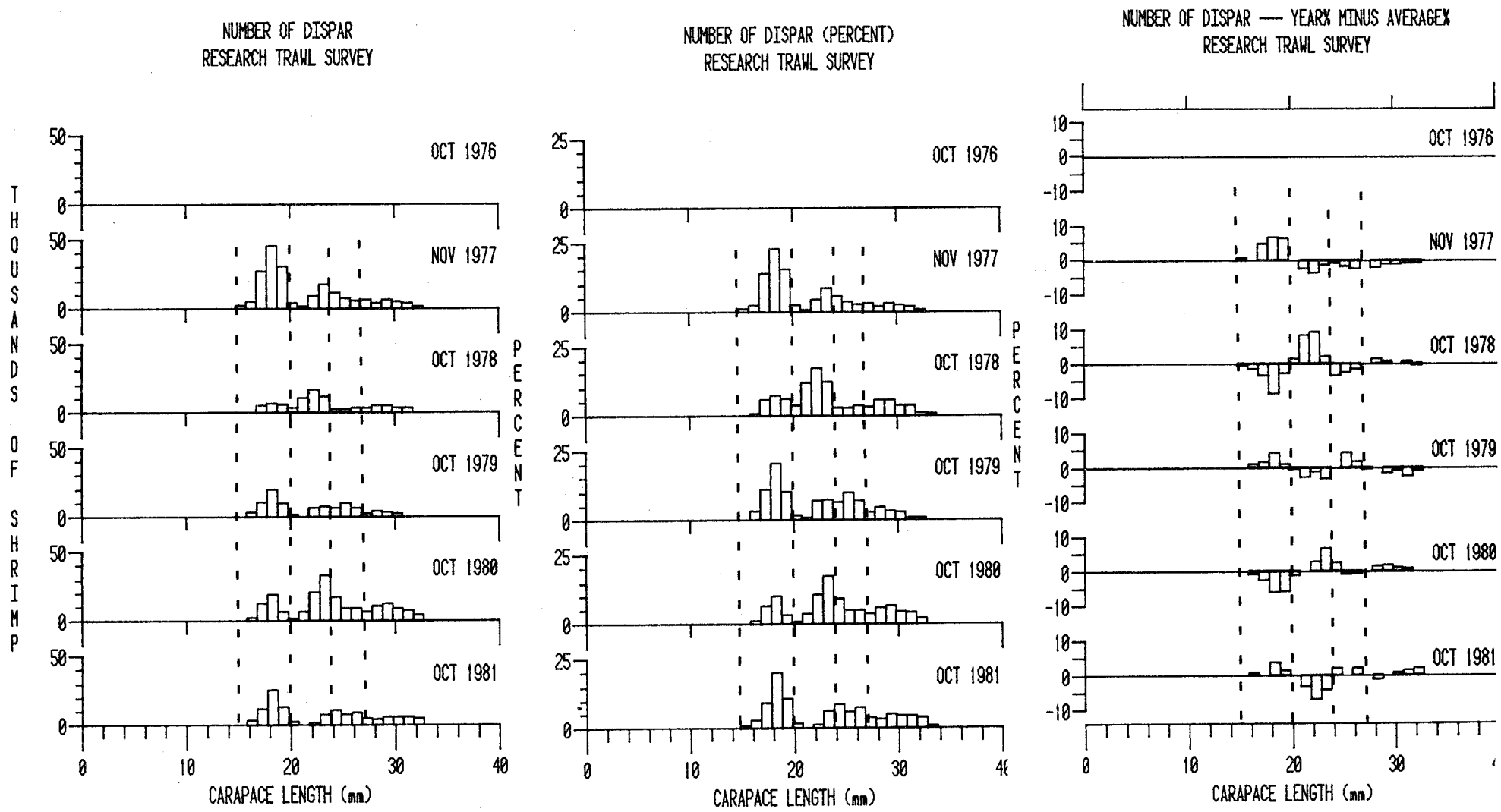
Appendix Figure 8. Carapace length frequency for coonstripe shrimp *P. hypsinotus* sampled from research trawl surveys.



Appendix Figure 9. Carapace length frequency for coonstripe shrimp *P. hypsinotus* sampled from fall research trawl surveys.

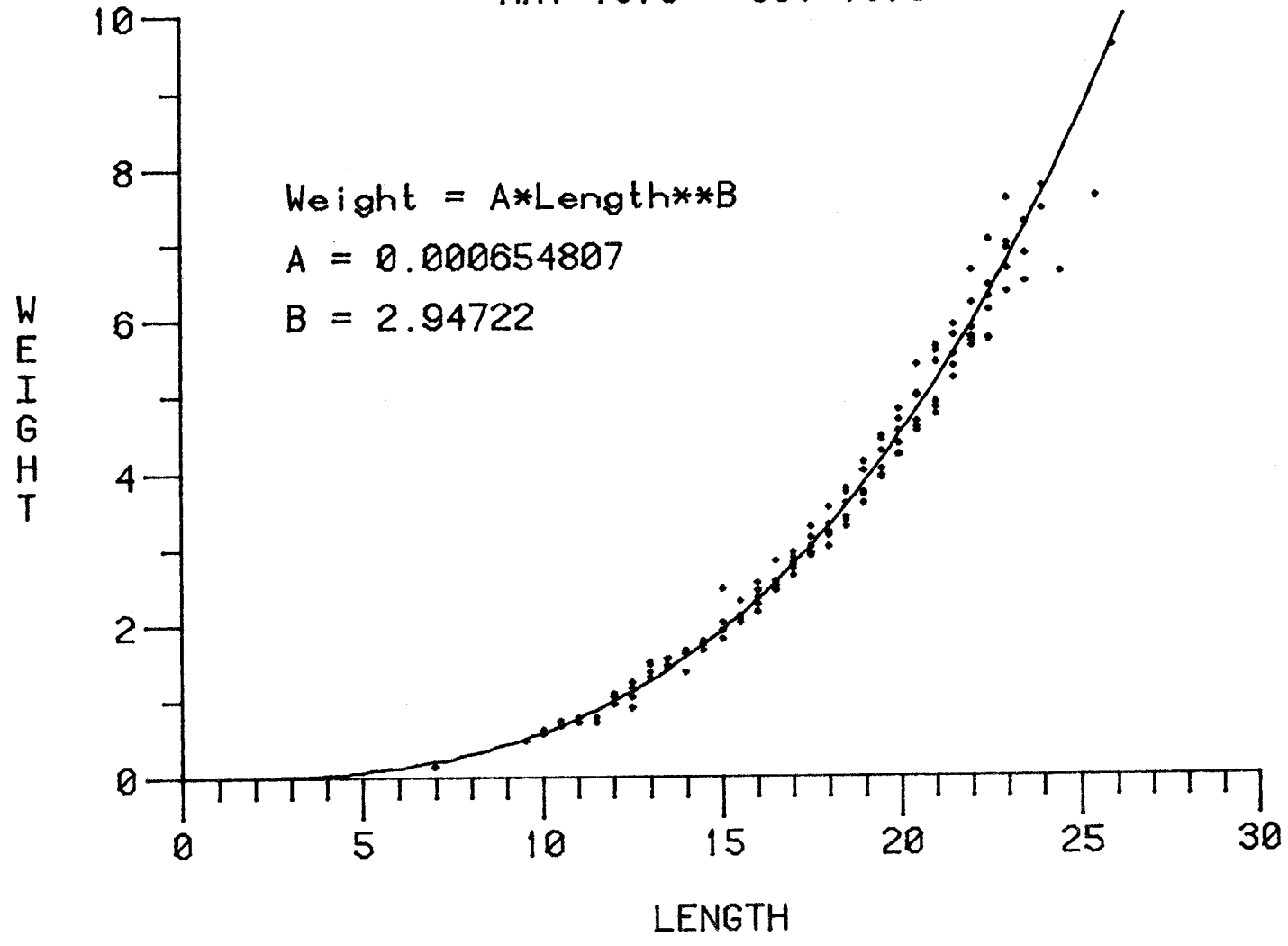


Appendix Figure 10. Carapace length frequency for sidestripe shrimp *P. dispar* sampled from research trawl surveys.

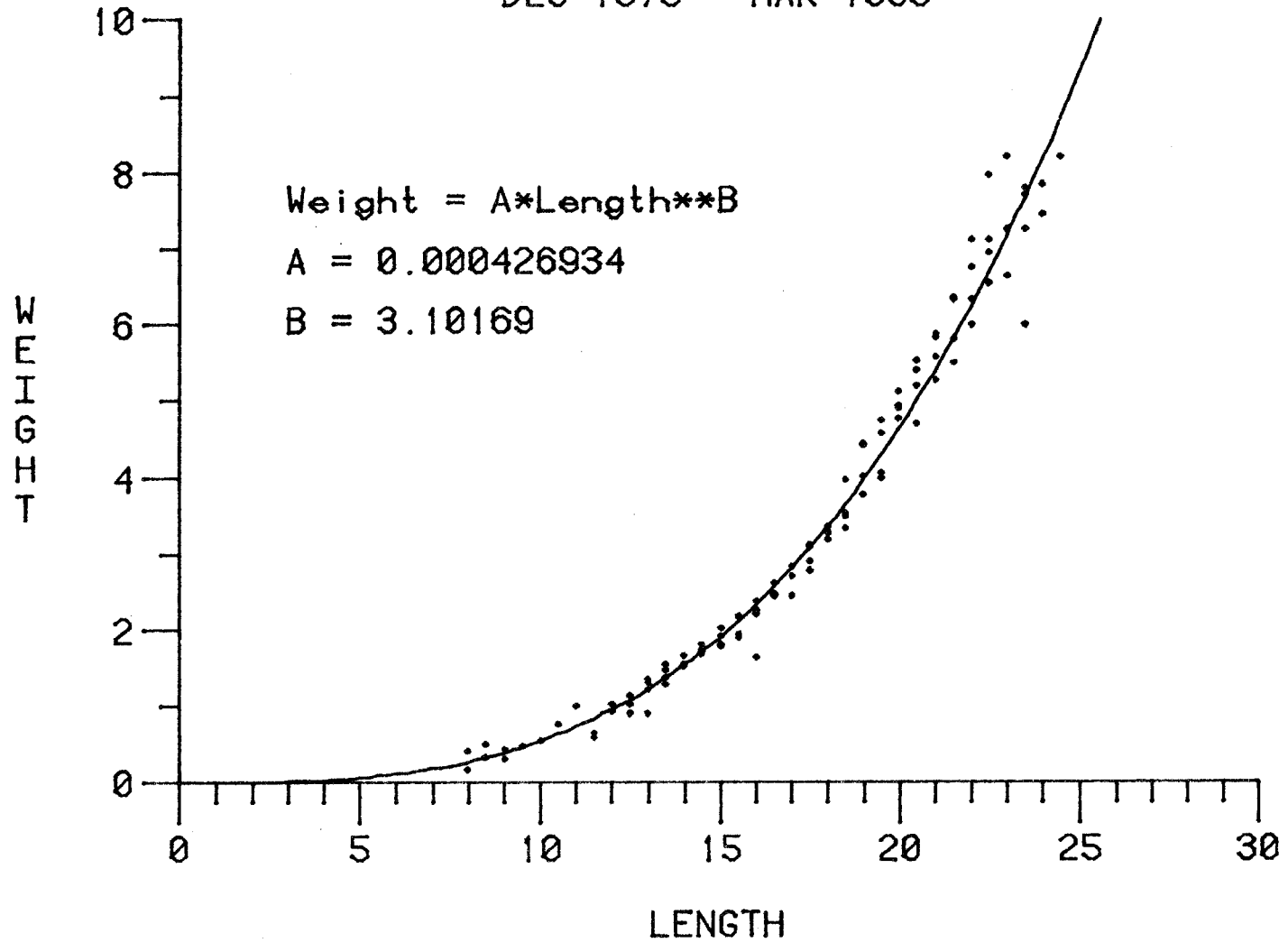


Appendix Figure 11. Carapace length frequency for sidestripe shrimp *P. dispar* sampled from fall research trawl surveys.

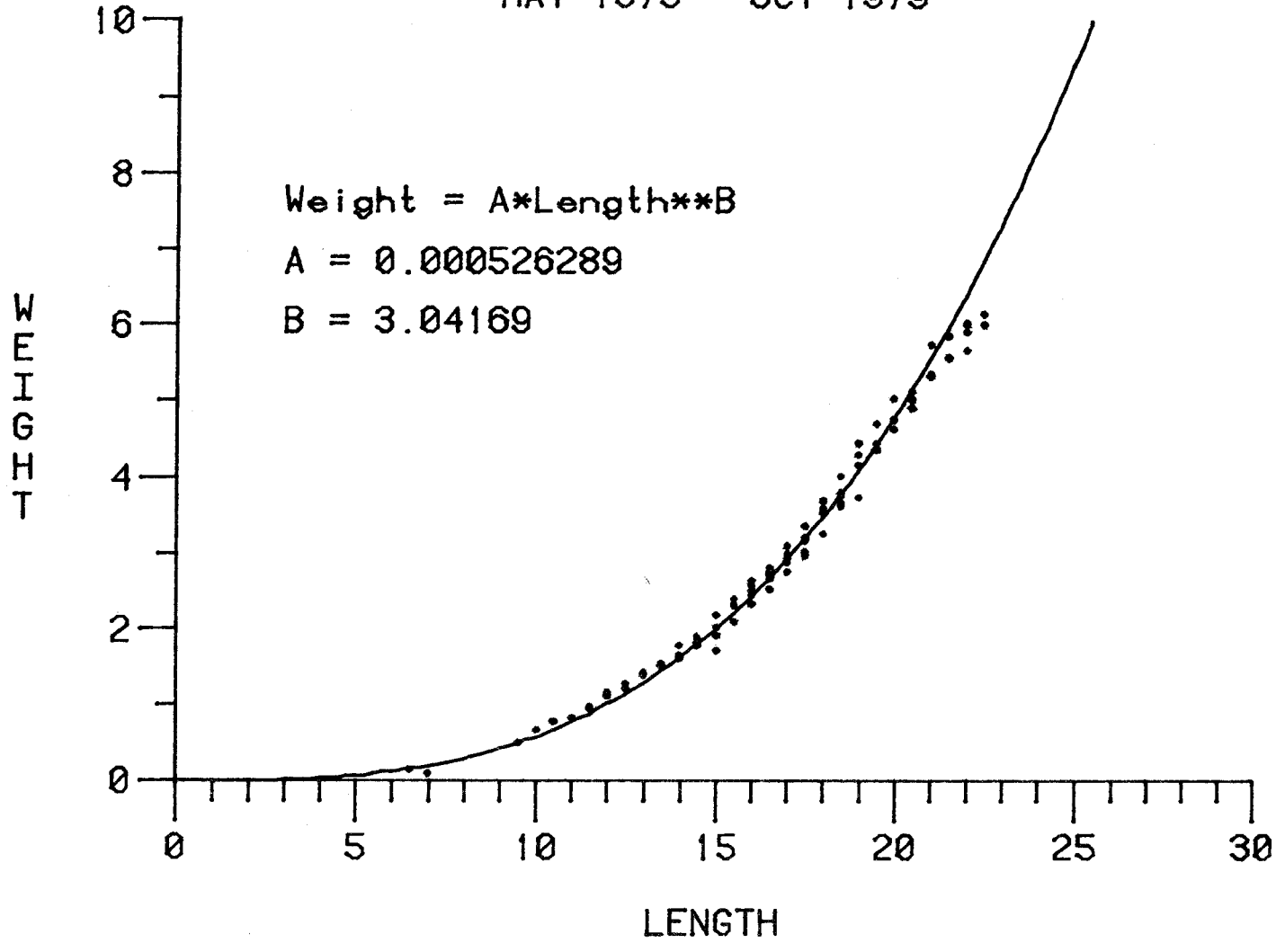
Appendix Figure 12. Length(mm) - weight(gms) relationship for pink shrimp taken in Southern District MAY 1979 - OCT 1979



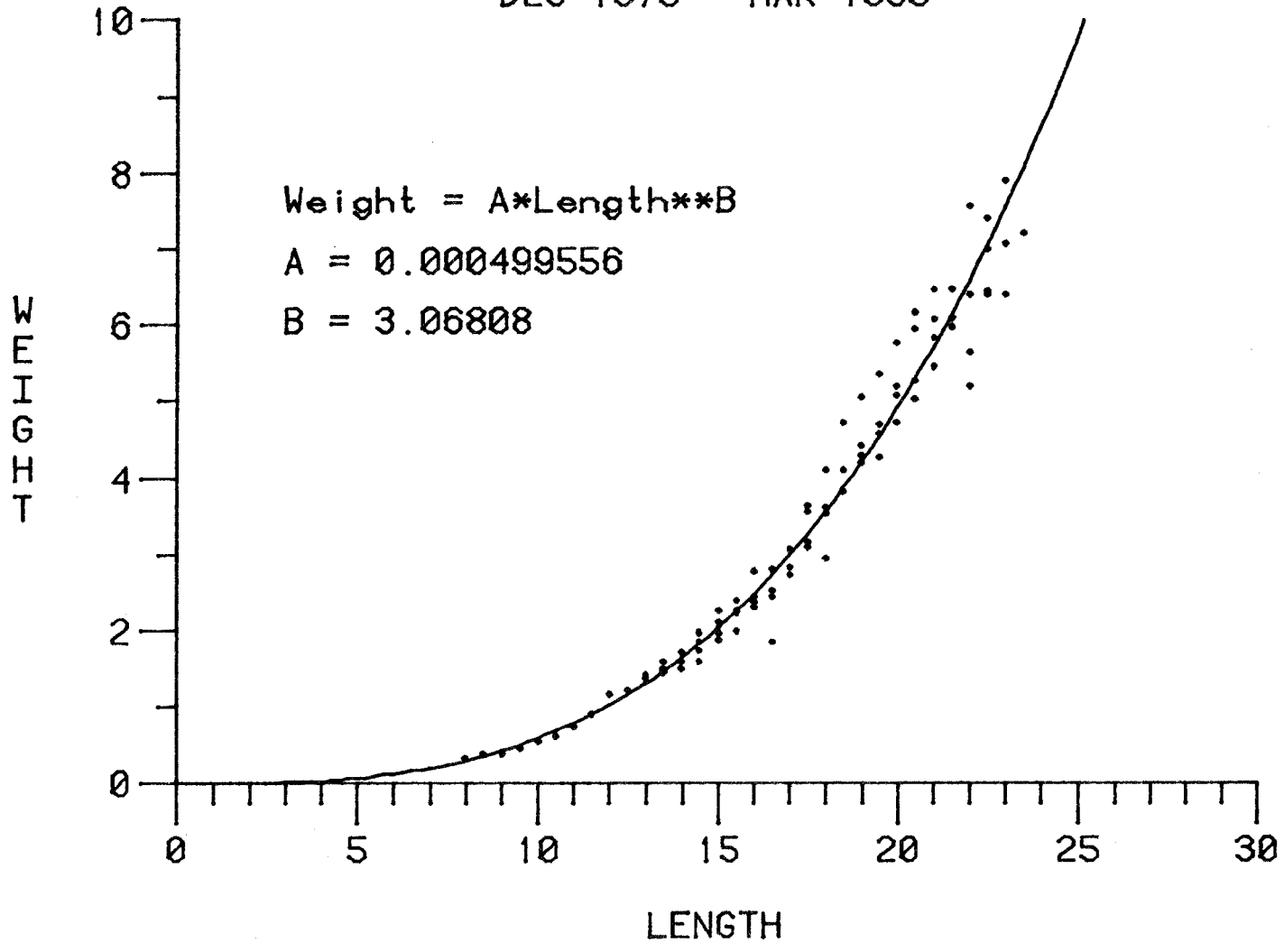
Appendix Figure 13. Length(mm) - weight(gms) relationship for pink shrimp taken in Southern District DEC 1979 - MAR 1980



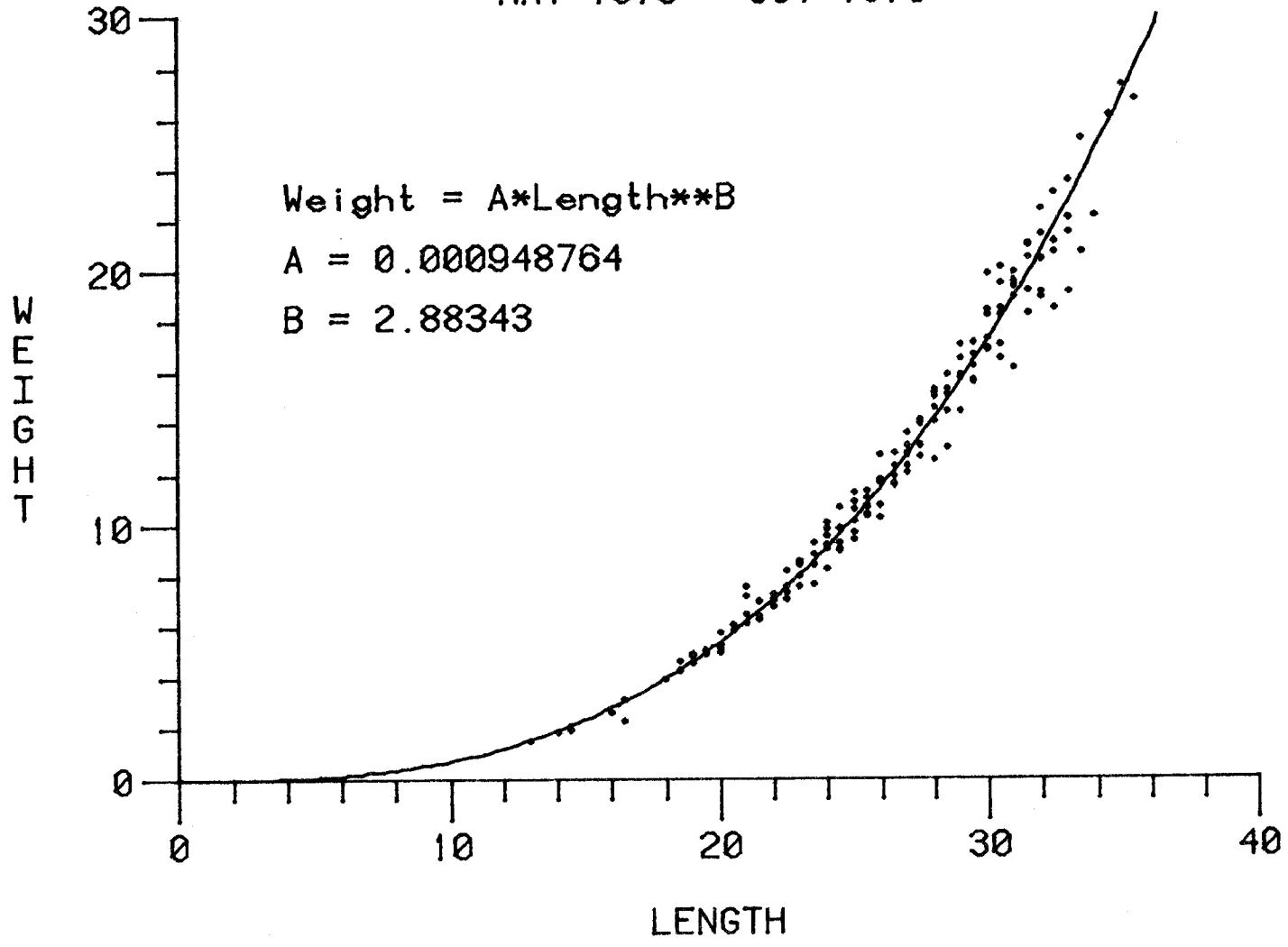
Appendix Figure 14. Length(mm) - weight(gms) relationship for humpy shrimp taken in Southern District MAY 1979 - OCT 1979



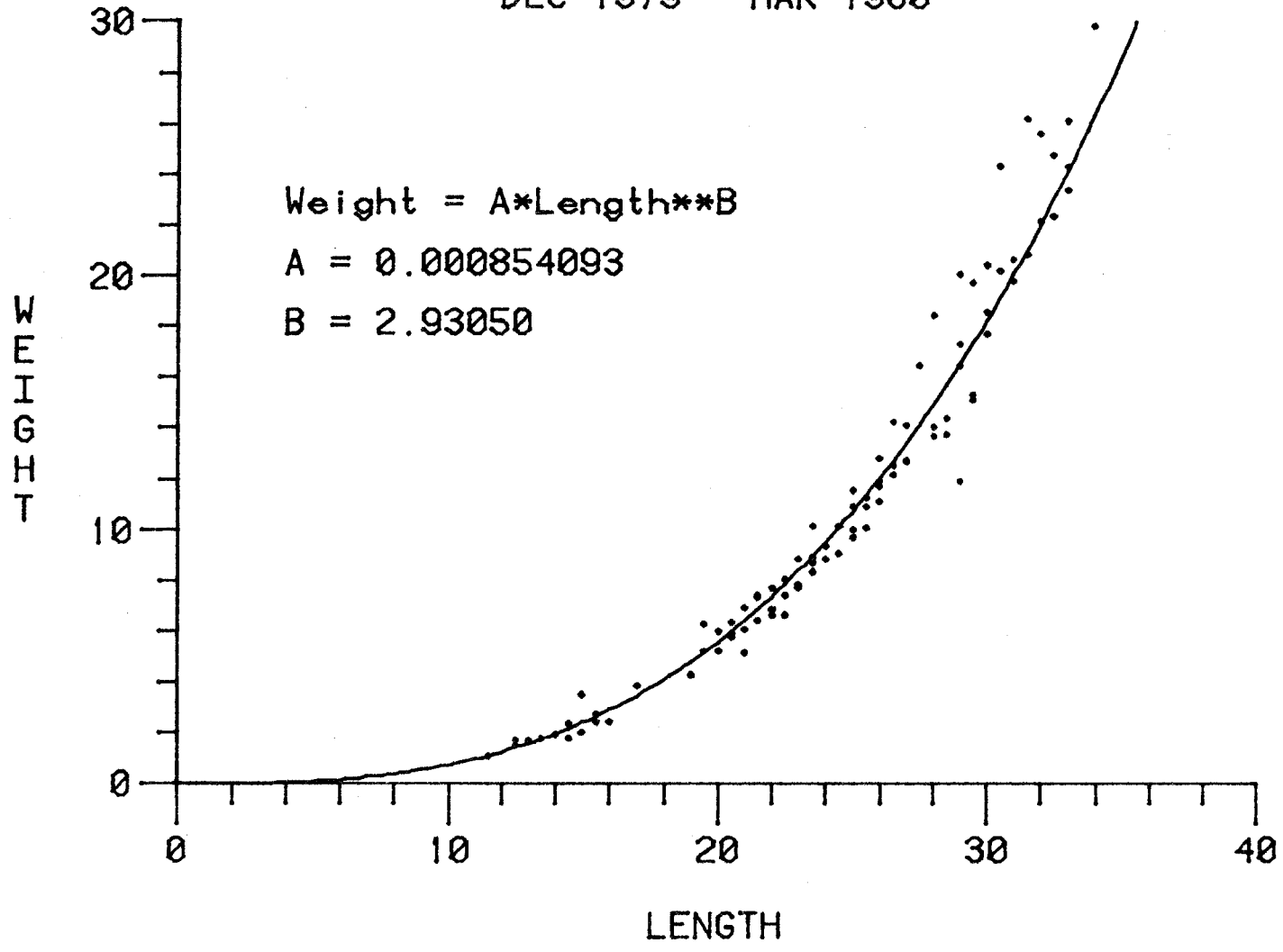
Appendix Figure 15. Length(mm) - weight(gms) relationship for humpy shrimp taken in Southern District DEC 1979 - MAR 1980



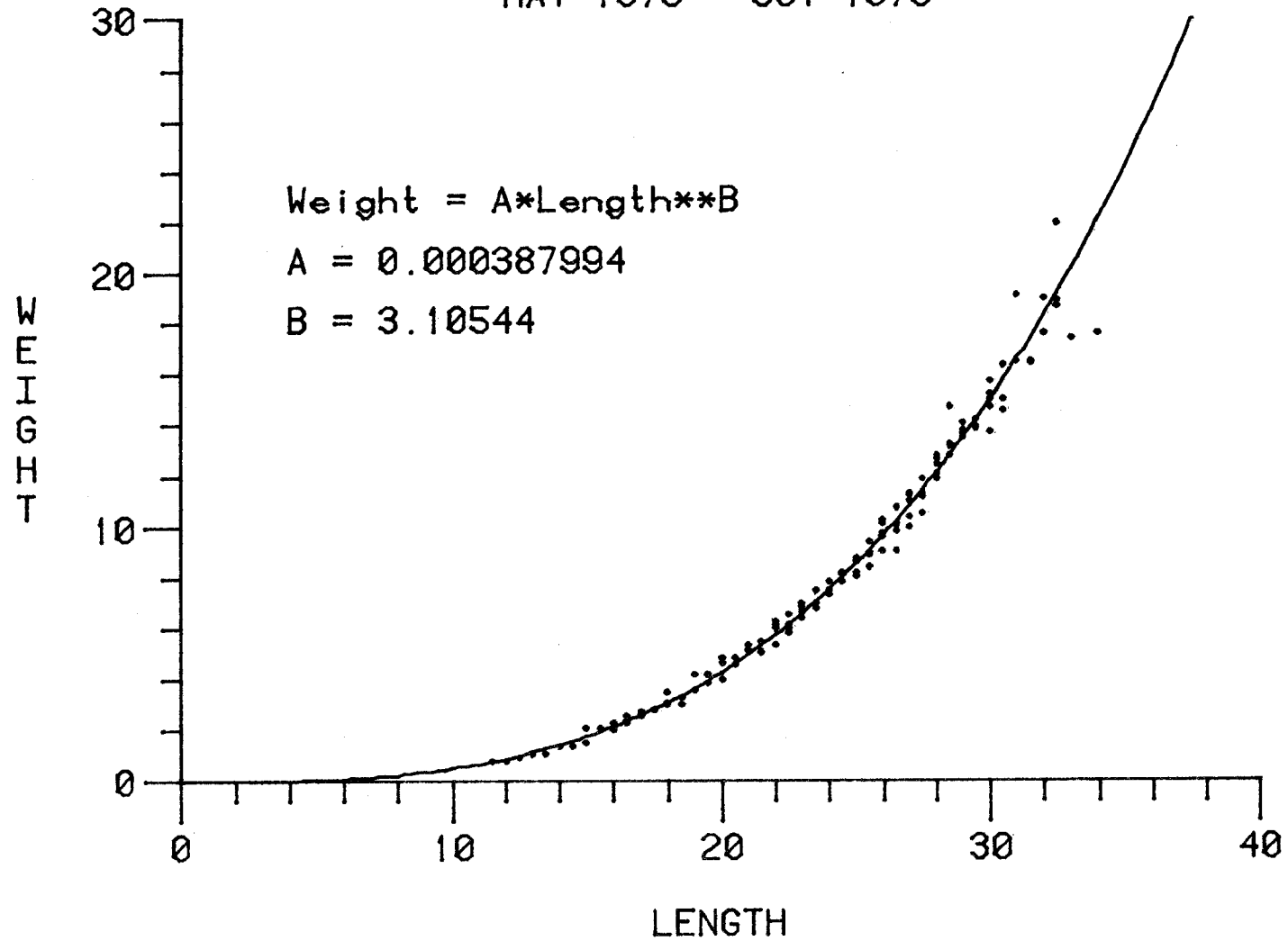
Appendix Figure 16. Length(mm) - weight(gms) relationship for coonstripe shrimp taken in Southern District MAY 1979 - OCT 1979



Appendix Figure 17. Length(mm) - weight(gms) relationship for coonstripe shrimp taken in Southern District DEC 1979 - MAR 1980



Appendix Figure 18. Length(mm) - weight(gms) relationship for sidestripe shrimp taken in Southern District MAY 1979 - OCT 1979



Appendix Figure 19. Length(mm) - weight(gms) relationship for sidestripe shrimp taken in Southern District DEC 1979 - MAR 1980